ILCA 1991:
Annual Report and Programme Highlights

International Livestock Centre for Africa

P O Box 5689, Addis Ababa, Ethiopia

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Contents

Financial summary
Source and application of funds, 1991 and 1990
Research expenditure by thrust

Foreword

ILCA can feel proud of its achievements in 1991. This was a difficult year, one in which the Centre faced two major problems — reduced funding and political and social unrest in several countries in which it works. Yet despite these, the Centre's research, training and information activities continued, with little or no loss of programme to either factor.

Almost all training activities planned for 1991 went ahead, some being moved to a different country to avoid local political instabilities. The *ILCA Annual Programme Report 1991* reports on progress in projects across Africa — some were slowed but almost none had to be abandoned because of the problems faced by the Centre. The number of research publications produced almost doubled compared with 1990. This, together with the Centre's handling of local instabilities, demonstrates the strength of ILCA and the dedication and fortitude of its staff.

Making better use of scarce resources

This report presents some of the highlights of ILCA's research and training and information programme. The central theme of the highlights is "making better use of scarce resources", whether natural resources throughout sub-Saharan Africa or funds for research in ILCA and its national-programme partners.

The highlight described for the Cattle Milk and Meat Thrust focuses on helping national agricultural research systems (NARS) make better use of their livestock production data. Many NARS have, over the years, collected vast amounts of livestock production data but have not been able to analyse them. In 1991, ILCA scientists helped NARS staff in Kenya analyse and interpret data from several cattle breeding programmes. The results will help increase the performance of the breeding programmes and boost livestock production in the country. In the same field, a major achievement in 1991 was the development of LIMS — the Livestock Information Management System — which will help scientists collect, analyse and manage livestock data. This program is designed to handle the large, complex data sets commonly generated by livestock production research. By helping standardise data sets, LIMS will facilitate comparisons and combination of results across sites and time, yet it is flexible enough to be used with a wide range of livestock species and production systems, both on station and on farm.

The highlights of both the Small Ruminant Meat and Milk Thrust and the Animal Traction Thrust centre on crop–livestock integration. As the small ruminant thrust highlight shows, livestock are often the key to encouraging farmers to adopt environment-friendly farming practices — in this case integrating forage legumes into the farming systems of the Sahel and the subhumid zone of West Africa. The traction thrust focuses on ILCA's work in the Ethiopian highlands, a central feature of which is the use of animal-drawn implements to improve management of clay soils. Part of an interdisciplinary, integrated study of the highland farming system, this work offers means of boosting whole-farm production while introducing practices that increase both the economic and environmental sustainability of the highland farming system.

The subject of the Animal Feed Resources Thrust highlight is ILCA's long-term investigation of range trends in the Gourma region of Mali, in West Africa. This work, started in 1984, is providing important insights into the mechanisms of changes in rangeland vegetation over an extended period of below-average rainfall. Key among the findings are the cyclical nature of changes in the flora of the rangelands and the dynamics of range trends. Range biomass production is clearly related to rainfall, even after extended periods of drought, allaying fears that the rangelands are too degraded to recover. Even the invasion of unpalatable grasses and broad-leaved plants may be beneficial, protecting remaining reserves of palatable, less hardy plants, allowing them to recolonise the range when conditions improve. The picture that emerges is complex, but clearly shows the resilience of the rangelands.

Trypanotolerant cattle are known to be more productive than non-trypanotolerant cattle where there is a risk of contracting trypanosomiasis. The results reported in the Trypanotolerance Thrust highlight demonstrate, for the first time, that this performance advantage extends also to lifetime reproductive performance — a key factor determining the overall productivity of a livestock production system.

Two of the themes highlighted in the Livestock Policy Thrust are provision of information to policy makers in Africa's NARS and using socio-economic research to identify target audiences for commodity research. Better-informed policy makers are essential if agricultural research is to have any great impact on agricultural production in sub-Saharan Africa, and provision of information is a key element of ILCA's policy work. In the same vein, research targeted to a specific audience is likely to have a greater impact than research with a more diffuse audience.

In all research, access to information is crucial to ensuring that the research effort is not wasted. The highlight on ILCA's Training and Information Department features the Centre's comprehensive information services. From providing NARS scientists with the information they need to develop effective, novel projects to publishing their results, ILCA facilitates the flow of information on animal agriculture in sub-Saharan Africa.

Looking to the future

The past year saw the completion of ILCA's third quinquennium and the conduct of the third External Programme and Management Review (EPMR) of the Centre. It was also the third year of the Centre's five-year programme and budget. The Centre is now developing a new medium-term programme and budget, for the period 1994–98. This will take into account recent developments in the Consultative Group on International Agricultural Research (CGIAR) and in Africa and increasing concerns for environmental issues.

As the programme highlights in this document clearly show, ILCA already has a strong awareness of and involvement in environmental issues. The likely environmental impact of all new research protocols is carefully evaluated before funding is considered. In 1991 the Centre spent 19% of its funds on Conservation/Management of Natural Resources (CGIAR Activity Category 1). This included work on rangeland management in southern Ethiopia and in Mali (Ecosystem Conservation, 10%), and germplasm collection and conservation (9%). Among the other CGIAR Categories of Activity, ILCA spent 4% of its

funds on Germplasm Enhancement/Breeding, 39% on Production Systems Development/Management, 10% on Socio-economic/Public Policy and Public Management Research and 28% on Institution Building. ILCA is continuing its close involvement in discussions of priorities for livestock research in the CGIAR system.

The EPMR, completed early in 1992, produced a positive report that will help ILCA in the development of the new medium-term plan. The Centre's Board of Trustees and management welcome the recommendations made in the report. These will contribute to the future success of the Centre.

In all, 1991 was a year ILCA can be proud of — a year of progress and achievements despite funding constraints and local political instabilities. We look forward to the future with increasing confidence in the strength of the Centre and its programme.

Dieter Bommer
Chairman, Board of Trustees

John Walsh
Director General

Sustainability and livestock

Livestock have often been blamed for harming the environment. People are familiar with scenes of devastated rangelands, and the media blame overgrazing for causing such degradation. But livestock are not always the rogues, they often actively contribute to the sustainability of agricultural systems. Moreover, they are one of the keys to helping a system rehabilitate degraded natural resources.

But first, what do we mean by "sustainable"? To many in the developed world, it evokes an image of "returning to the old ways".

Agriculture in the developed world consists largely of intensive production systems — vast tracts of uniform crops fertilised and treated with chemicals, specialised, high-input animal production units. The public sees these systems damaging the environment — polluting water supplies with nitrates, eroding the genetic base of the crops and livestock we depend on — while producing huge surpluses of food that go to waste. The alternative is seen to be a return to less-intensive, 'organic' farming systems that are thought to be kinder to the environment. After all, goes the argument, agriculture has supported mankind for millennia without destroying the planet. So the old ways must have been sustainable.

But in the developing world it is the "old ways" that can no longer support the population without harming the environment.

Populations in the developing world are increasing rapidly — the population of sub-Saharan Africa is expected to double in the next 20 years. Farmers are driven by economic realities to produce more food to pay for things they cannot make themselves, to improve their life-style. As pressure on the land increases, driven by the ever-increasing need to grow more food for the burgeoning human population, farmers have to plough and crop less-productive land. Fallow periods, the key to many traditionally sustainable production systems, get shortened or even eliminated. The need to extract as much as possible from their land leads farmers to adopt practices that "mine" the land, to the cost of future generations.

Environmental concerns feature heavily in the concept of sustainability — protection or enhancement of the environment are foremost in many people's minds. Images of degraded rangelands becoming deserts and once-forested areas stripped of their trees are common in the developed-world press. But people must feature too. Improved agricultural systems must meet the desires of people or they are doomed to fail. And they must be flexible enough to evolve and develop to continue to meet the changing needs and desires of society. To a large extent, this means increasing output.

A sustainable agricultural system is thus one that maintains or enhances the quality of the environment, meets current and future demands of the society and ensures the economic and social welfare of the farming community.

Increasing output and preserving or improving the environment may seem mutually exclusive goals. But both can be achieved through judicious marshalling of resources.

Livestock can play a vital role in this process. They are central to nutrient cycling. Their manure is often the only fertiliser available to farmers in the developing world. They can transfer nutrients from renewable sources, such as rangelands, to crop lands, replacing those removed by the crops.

More importantly, livestock provide an "entry point" for many practices that help promote sustainability, such as introducing forage legumes in the cropping system. A prime example of this is fodder banks — small, intensively managed pastures of forage legumes intended initially to provide high-quality dry-season feed for cattle in subhumid Nigeria. While fodder banks were originally targeted at livestock owners, they have dramatic benefits for food-crop production — vitally important since the land is largely in the hands of crop farmers who keep no livestock. Maize yields up to 2.5 tonnes more grain per hectare on land that has been under the forage legume for two or three years than it does on land that has been fallowed for six years. Added to that, the soil is easier to till following the legume. The soil is under a plant cover for most of the year, protecting it from wind and rain erosion. And livestock productivity is increased. All round, farmers, livestock owners and the environment benefit. But without the cash-earning livestock, there would be less incentive for the crop farmers to plant the legumes.

Forage legumes tend to remain on the land for longer periods and develop greater ground cover than other crops, so they provide more protection for the soil over longer periods. They are planted at higher densities than food legumes and this, coupled with their generally more extensive rooting system, increases the contribution of their roots to building up soil organic matter and improving soil structure. Another benefit of forage legumes to the soil is that they are usually grazed where they grow. The nutrients in the animals' manure and urine return to the soil where the plants grew, replacing the nutrients extracted by the plants.

But, obviously, forage legumes are not an end in themselves — farmers will only grow them if there is a use for them, and that means livestock. The impetus for farmers to grow forage legumes may lie in the greater yields they get from their crops, but the corollary increase in livestock production will benefit the human population.

A major benefit of livestock is that they can help make food available throughout the year. Crops tend to be harvested once a year, at the end of the growing season. In contrast, livestock can be "harvested" at any time of year. This is especially true of milk, which can be produced year-round. Greater use of animal traction to "mechanise" tillage and weeding can release people for other tasks. In the Ethiopian highlands, for example, women freed from manually building broadbeds for crops are turning to cottage-industry activities such as making carpets.

Thus, increasing livestock production, in all its forms, will likely improve human nutrition and increase farm income, which in turn is likely to lead to increased investment in crop production — better seeds and fertiliser. As standards of living rise, so should investment in human health and education.

The opportunities are there to break the desperate cycle of increased cropping, land degradation and poverty. ILCA sees livestock production not as an end in itself, but as central to the development of sustainable farming systems for sub-Saharan Africa.

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ILCA's addresses

Headquarters
ILCA
P O Box 5689
Addis Ababa, Ethiopia
Telex: 21207 ILCA ET
Tel: (251–1) 61 32 15
Fax: (251–1) 61 18 92
E-mail: CGI070

Liaison/Facilitation offices
ILCA/CIPEA
BP 60
Bamako, Mali
Telex: 2459 ILCA MJ
Tel: (223) 22 21 77/22 42 71
Fax: (223) 22 42 79
E-mail: CGI356

ILCA
P O Box 3211
Harare, Zimbabwe
Telex: 22462 CIMMYT ZW
Tel: (263–4) 70 62 45
Fax: (263–4) 70 62 45
E-mail: CGI357

Thrust coordination
Cattle Milk and Meat Thrust
Animal Feed Resources Thrust
Livestock Policy and Resource Use Thrust
Animal Traction Thrust

ILCA
P O Box 5689
Addis Ababa, Ethiopia
Telex: 21207 ILCA ET
Tel: (251–1) 61 32 15
Fax: (251–1) 61 18 92
E-mail: CGI070

Small Ruminant Meat and Milk Thrust

ILCA
P O Box 80147
Mombasa, Kenya
Telex: 21465 ILCAKS KE
Tel: (254–11) 48 58 42
Fax: (254–11) 48 62 07
E-mail: CGI359

Trypanotolerance Thrust

ILCA
P O Box 46847
Nairobi, Kenya
Telex: 25747 ILCA KE
Tel: (254–2) 63 20 66/63 21 22/63 20 13
63 20 93
Fax: (254–2) 63 14 81
E-mail: CGI358

Zonal research sites

Highlands
ILCA
P O Box 5689
Addis Ababa, Ethiopia
Telex: 21207 ILCA ET
Tel: (251–1) 61 32 15
Fax: (251–1) 61 18 92
E-mail: CGI070

Humid zone
ILCA
PMB 5320
Ibadan, Nigeria
Telex: 31417/31159 TROPIB NG
Tel: (234–22) 40 03 00/14
E-mail: CGI072

Subhumid zone
ILCA
PMB 2248
Kaduna, Nigeria
Telex: 71384 ILCAKD NG
Tel: (234–62) 21 13 89
Fax: (234–62) 23 05 26
E-mail: CGI154

ILCA
P O Box 80147
Mombasa, Kenya
Telex: 21465 ILCAKS KE
Tel: (254–11) 48 58 42
Fax: (254–11) 48 62 07
E-mail: CGI359

Subhumid/semi-arid zone
ILCA/CIPEA
BP 60
Bamako, Mali
Telex: 2459 ILCA MJ
Tel: (223) 22 21 77/22 42 71
Fax: (223) 22 42 79
E-mail: CGI356

Semi-arid zone
ILCA/ICRISAT
BP 12404
Niamey, Niger
Telex: 5406/5560 ICRISAT NI
Tel: (227) 72 25 29
Fax: (227) 73 43 29
E-mail: CGU004

Coordinators and committee chairmen of ILCA-associated networks

(as at 5 May 1992)

Cattle Research Network

Coordinator

Dr E A Olaloku
ILCA/CIPEA
BP 60
Bamako
Mali

Telex: 2459 ILCA MJ
Tel: (223) 22 21 77/22 42 71
Fax: (223) 22 42 79
E-mail: CGI356

Steering Committee Chairmen

West and central Africa

Dr M Mbaye
ISRA–LNERV
BP 2057
Dakar
Senegal

Telex: 51403 INTERVET SG

East and southern Africa

Prof M Mgheni
Department of Animal Science and Production
Sokoine University of Agriculture
Morogoro
Tanzania

Telex: 55308 UNIVMOG TZ

African Small Ruminant Research Network

Coordinator

Dr S H B Lebbie
ILCA
P O Box 46847
Nairobi
Kenya

Telex: 25747 ILCA KE
Tel: (254–2) 63 20 13/63 20 66/63 21 22
63 20 93
Fax: (254–2) 63 14 81
E-mail: CGI358

Steering Committee Chairman

Dr Beyene Chichaibelu
Alemaya University of Agriculture
P O Box 138
Dire Dawa
Ethiopia

West African Animal Traction Network

Network Research Coordinator

Dr P Lawrence
ILCA/ICRISAT
BP 12404
Niamey
Niger

Telex: 5406/5560 ICRISAT NI
Tel: (227) 72 25 29
Fax: (227) 73 43 29
E-mail: CGU004

Steering Committee Chairman (acting)

Dr A Faye
Centre de recherches zootechniques de Kolda
Institut sénégalais de recherches agricoles (ISRA)
BP 53
Kolda
Senegal

African Feed Resources Network

Coordinator

Dr J Ndikumana
ILCA
P O Box 46847
Nairobi, Kenya

Telex: 25747 ILCA KE
Tel: (254–2) 63 20 13/63 20 66/63 21 22
63 20 93
Fax: (254–2) 63 14 81
E-mail: CGI358

Steering Committee Chairmen

East and southern Africa
Dr N A Urio
Department of Animal Science
Sokoine University of Agriculture
P O Box 3004 Chuo Kikuu
Morogoro
Tanzania

Telex: 55308 UNIVMOG TZ

West and central Africa
Dr E Agishi
c/o NAPRI
PMB 1096
Zaria, Nigeria

Telex: 71384 ILCAKD NG
Tel: (234–62) 21 13 89
Fax: (234–62) 23 05 26
E-mail: CGI154

African Trypanotolerant Livestock Network

Coordinator

Dr G D M d'Ieteren
ILCA
P O Box 46847
Nairobi
Kenya

Telex: 25747 ILCA KE
Tel: (254–2) 63 20 13/63 20 66/63 21 22
63 20 93
Fax: (254–2) 63 14 81
E-mail: CGI358

African Livestock Policy Analysis Network

Coordinator (acting)

Dr S Ehui
ALPAN
ILCA
P O Box 5689
Addis Ababa
Ethiopia

Telex: 21207 ILCA ET
Tel: (251–1) 61 32 15
Fax: (251–1) 61 18 92
E-mail: CGI070

Sahelian Rangeland Monitoring Network

Coordinator and Chairman

Dr Guigma Salif
SPVA/CILSS
BP 7049
Ouagadougou
Burkina Faso

Telex: 5263/5362 COMITER
Tel: (226) 30 60 51
Fax: (226) 30 72 47

Cattle Milk and Meat Thrust

Most African countries have pursued livestock breeding programmes and breed evaluation studies in their search for increased livestock production. Unfortunately, these studies often use different methodologies and vary in the type of data collected and how they are collected. In addition, many of the data have not been analysed because African national agricultural research systems (NARS) generally lack the computers and biometrical expertise needed to analyse large, complex data sets.

In 1991, ILCA focused its assistance to NARS on two breed evaluation projects — one involving assistance in evaluating cattle breeding programmes and one developing a microcomputer-based system that facilitates management of livestock production data.

Assistance to NARS

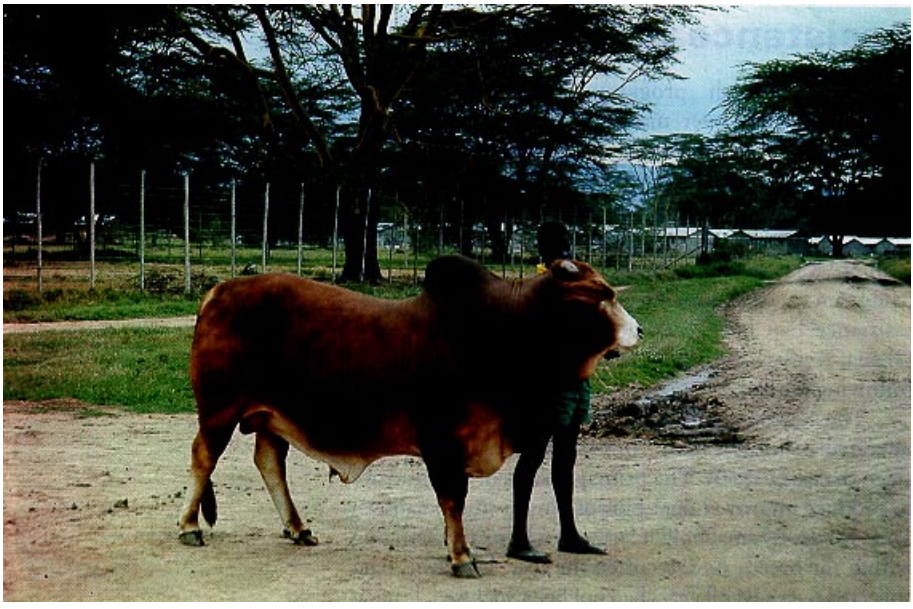
Livestock research programmes can collect vast amounts of data over many years. However, unless these data are subject to thoroughgoing analysis, the value of such research programmes remains, at best, in doubt.

ILCA has, over a number of years, been working with NARS in several countries in collating and analysing data from breed evaluation studies. By the end of 1991, assistance had been provided to NARS in Ethiopia, Ghana, Kenya, Malawi, Swaziland and Zimbabwe. The following reports focus on work done in 1991 in Kenya.

The National Sahiwal Stud at Naivasha, Kenya, has operated a "closed-herd" breed improvement system since the early 1960s. The principal aims of the Stud are to produce improved dual-purpose (meat–milk) Sahiwal cattle for use by smallholder farmers in Kenya by selecting within the breed. As is so often the case, however, data collected over several years had not been analysed, leaving research staff at the Stud unaware of what changes were being effected in the Sahiwal population at the Stud.

During 1991, ILCA scientists helped analyse performance data collected between 1963 and 1988, bringing to light some important information on the performance of the breeding programme.

The results showed that the genetic progress that the Sahiwal breed improvement programme was making was unacceptably low — genetically, milk yield was increasing by 4.2 kg a year and calving interval was falling by 0.31 days a year, while changes in birth weight and age at 55 kg liveweight were negligible. Of more concern, actual milk yields fell by 12.7 kg a year and calving interval lengthened by 2.72 days a year. These phenotypic changes, the result of a combination of the animal's genetic potential and the effect of its environment, reflect a deterioration in management of the animals in the latter part of the period covered by the data. The study also revealed a high and increasing level of inbreeding, with its potential negative impact on breed performance.



A Sahiwal bull at the National Sahiwal Stud, Naivasha, Kenya. ILCA assistance in analysing data gathered by scientists at the Stud has helped improve Prospects for genetic progress in the Sahiwal breed improvement programme.

The findings of the study indicate that the Stud needs to increase the selection pressure applied and improve its management of the animals. The results also support a decision taken in 1989/90 to open the Stud herd and bring in new breeding stock to reduce inbreeding and broaden the genetic base. Investigations are now under way to improve the selection approach used at the Stud.

Other work in Kenya assessed the performance of the Friesian bulls at the national AI Stud and the Jersey herd at the Kenya Agricultural Research Institute's Mtwapa station near Mombasa.

Artificial insemination of dairy cattle has been widely practised in Kenya since the 1940s. By the 1960s, demand for semen had outstripped supply available from imported dairy bulls and the Kenyan Dairy Cattle Improvement Programme established two new programmes, the Progeny Testing Programme (PTP) and the Contract Mating Scheme (CMS). The PTP aimed at determining the genetic merit — breeding value — of bulls at the AI Stud, using production records of their daughters raised in Kenya. The object of the CMS was to produce bulls for use by the AI Stud, using superior local cows inseminated with imported semen and semen from top progeny-tested local bulls. However, up to 1990 the programmes had never been comprehensively evaluated.

In 1990/91, staff from the Kenya Dairy Cattle Improvement Programme, working with ILCA scientists, analysed a total of 28 065 lactation milk yield records, 8367 records for age at first calving and first lactation milk yield and 9446 records for calving interval from daughters of Friesian bulls at the AI Stud. These records covered a 20-year period, from 1968 to 1987.

The analyses clearly showed that, early in its life, the PTP was having the desired effect and the quality of the bulls in the AI Stud was increasing. ("Quality" here refers to a bull's ability to father cows that give superior milk yields.) However, from 1977–79 onwards the genetic merit of the bulls began to decline.

These results have both positive and negative aspects. The early progress shows that there is potential for increasing dairy productivity through bull testing and selection. The poor performance in later years largely reflects difficulties in maintaining an effective recording scheme together with increasing demand for semen. Because of the high demand for semen, most bulls tested were retained and used by the Stud. In consequence, no selection was applied and many of the bulls at the Stud had negative "proofs" — i.e. the productivity of their offspring is below the average for the population. Using such bulls in the AI programme reduces overall herd productivity rather than enhancing it.

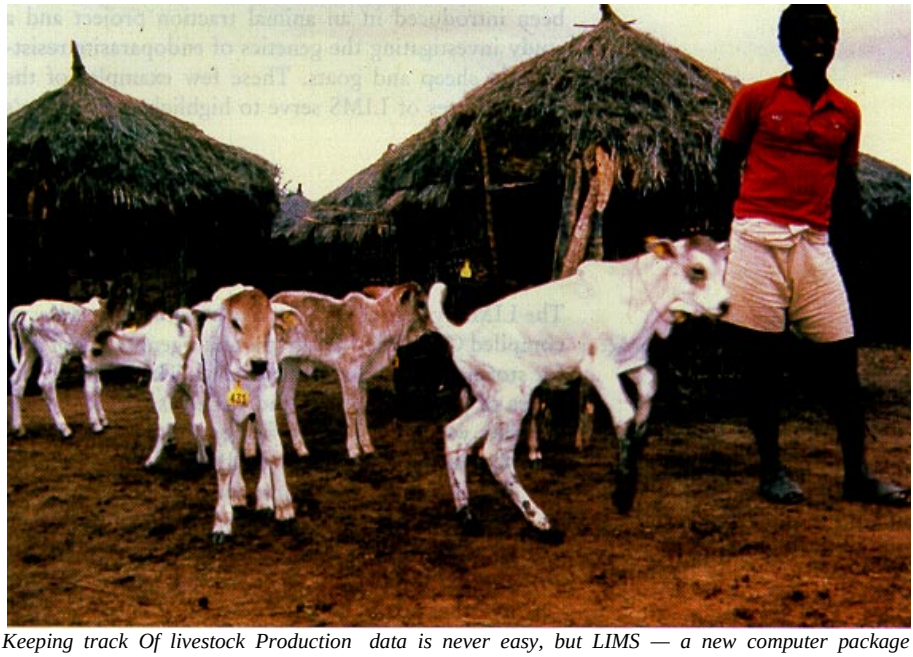
As a result of this study, recommendations have been made for the reorganisation of the Kenyan national breeding plan and its management. The prospects for increasing the productivity of the national Friesian herd (and the Ayrshire, Jersey and Guernsey herds, which are also covered by the AI Stud) have thus improved.

The Mtwapa study again emphasised the importance of animal management, particularly with high-yielding dairy cows. Average lactation milk yields at Mtwapa declined from about 2250 kg in the 1960s to about 1500 kg from 1980 onwards. Over the same period, mean calving interval underestimated the deterioration in the reproductive performance of the herd. Calving percentages calculated from mean calving intervals declined from 93% for cows born in 1961–67 to 86% for those born in 1973–79, compared with calving percentages of 86 and 66% calculated from the number of parities per year of the cow's productive life. Thus, the proportion of infertile cows increased sharply in later years of the study. However, the study clearly showed that these changes were largely non-genetic — i.e. they resulted from poorer management in later years.

Better data management

In each of the studies mentioned here, large amounts of data had to be painstakingly gathered, entered on computer files, validated and analysed. Much of the data entry and analysis was done years after the data had been collected. Consequently, the data could be used only for "after-the-fact" analyses, not as the basis of managing the herds or for timely breeding recommendations. Delays between collection, entry and analysis of data also increase the risk of data being lost or records having to be discarded because they are incomplete or their accuracy is questionable.

Computerised data-management programs provide the obvious answer, but commercial packages that are designed for collecting, handling and analysing livestock production data tend to be targeted at a single species and production system, for example intensive dairying with cattle. The alternative is to use general-purpose data-management software, such as various data-base packages. These, however, cannot handle the more complex aspects of animal production data sets, require extensive programming and are generally not "user friendly".



Keeping track Of livestock Production data is never easy, but LIMS — a new computer package developed by ILCA — should help

ILCA's first effort at developing a computer program to aid collection and analysis of livestock production data was IDEAS — the ILCA Data Entry and Analysis System. IDEAS was released in 1986 and by the end of 1987 it was in use in 24 projects, maintaining records on 254 herds. The drawbacks of IDEAS were that it had fixed data structures and its built-in analysis module was relatively inflexible, largely reflecting the limitations of computers and software available in the mid 1980s.

In 1990, ILCA started to develop a replacement for IDEAS that would overcome these shortcomings. The major parts of the new package — LIMS or the Livestock Information Management System — were completed and tested in 1991. The complete system is now available and is already in use with several small and medium-sized data sets, including data from a large dairy farm, on-farm performance surveys with sheep and several on-station experiments. LIMS has recently been introduced in an animal traction project and a study investigating the genetics of endoparasite resistance in sheep and goats. These few examples of the range of uses of LIMS serve to highlight the system's flexibility.

Areas of data management addressed by LIMS

The LIMS system consists of five integrated modules of compiled CLIPPER[1] programs and a generic set of files for storing animal performance data. This consists of a series of pre-defined files and variables (fields) within the files, which can be modified by the individual user. Raw data are stored in standard dBASE[2] files.

1. Registered trade mark of Nantucket Corporation.
2. Registered trade mark of Borland International.

The five modules that make up LIMS are:

- SETUP: allows users to customise the generic data set to meet their specific needs and document the data set to facilitate archiving and subsequent use by other people.

- UPDATE: for data entry and editing. Extensive user assistance and cross-referencing during data entry help to reduce manual checking and calculation. A documentation file is provided that can store descriptive information such as research protocols, husbandry or management procedures and programs to access and analyse the raw data.
- VALIDATION: checks the entire data set for errors or inconsistencies and produces a printed error report.
- REPORTING: produces standard reports, such as population summaries (e.g. herd structure at a given date, entry/exit of animals into/from the herd over a given period) and action lists (e.g. a list of animals attaining weaning age during a given, future period).
- EXTRACTION: provides the interface between the mainly data-management-oriented LIMS system and commercial statistical analysis packages such as SPSS[3] and SAS[4].

3.Registered trade mark of SPSS Inc.
4.Registered trade mark of SAS Institute, Inc.

Advantages of LIMS

For the individual scientist, the advantage of using LIMS lies in its flexibility in designing data sets. The program helps ensure the quality of data by making the scientist define his or her data set before it is entered, and by facilitating subsequent checking of the data for plausibility and internal consistency. Data validation and preliminary data analysis can be carried out at the same time that data are entered, without having to rely on specialist computer and data-management support. This, in turn, helps shorten the time between completing a project and final analysis of the data.

From the institutional point of view, the advantages of using LIMS lie mainly in its standardisation and documentation of data recording. Not only can data sets from different species, production systems and research sites follow standardised formats, but customised data-analysis programs can also be re-used with minimum modification. The documentation features of the LIMS system, together with the concept of integrating the documentation of the data set with the raw data, means that a LIMS data set can be archived with little or no external documentation and yet still make sense to secondary users years after the work was originally done.

LIMS — a flexible data-management tool

The LIMS system is a very flexible tool for managing animal performance data and is applicable in a variety of situations. It helps ensure the quality and accessibility of data by applying extensive error-checking and by storing the data definition and documentation along with the raw data. The LIMS system can be especially useful with complex data that are recorded over an extended period, as in breed evaluation studies and breeding programmes.

The studies presented at the beginning of this report show a need for better data management in African NARS. LIMS will help NARS improve their management of livestock production data, providing them with the facilities for timely analysis and interpretation of their results. This, in turn, will result in greater pay-offs from research — early analysis means early application.

Small Ruminant Meat and Milk Thrust

Livestock are often blamed for harming the environment. This charge is particularly levelled at goats because they can still thrive after other domesticated livestock have had to be withdrawn for lack of feed.

But ILCA's research shows how livestock can, in fact, actively promote environment-friendly farming practices that can help prevent the initial stages in the cycle of land degradation.

Most African smallholders focus primarily on producing the food crops on which they and their families subsist. As the human population has increased, the amount of land available to each farmer has decreased, forcing farmers to intensify their production. In particular, fallow periods have been shortened or eliminated in the drive for food production. But this jeopardises future production and the environment.

Fallowing is essential to maintain soil fertility and structure in the absence of manuring or inorganic fertilisers. But in the fallow year, fallowed land produces neither food for the farmer nor a product that can be sold.

Livestock can provide the incentive for farmers to re-introduce fallow periods to their crop rotations and to use other environment-friendly methods. For example, instead of leaving land fallow, farmers can grow forage legumes during the fallow year. The legumes provide high-quality feed for livestock, boosting milk and meat production — poor nutrition is commonly the main limitation to livestock performance in sub-Saharan Africa — giving the farmer an immediate economic incentive to fallow his or her land. In addition, legumes improve soil fertility and structure, boosting subsequent crop yields.

Livestock thus provide the initial economic impetus for farmers to adopt practices that promote environmentally sustainable farming systems. Small ruminants have a particular role to play in promoting legume-based cropping systems — more African farmers own sheep and goats than own cattle. For example, in the coastal subhumid zone in Kenya, nearly half the farmers have only small ruminants, one in seven owns small ruminants and cattle but only one in 20 keeps only cattle. The pattern of ownership is similar elsewhere.

This report highlights work by ILCA aimed at integrating crop and livestock production in smallholder, mixed-farming systems to the benefit of the farmer and the environment.

Promoting sustainable Crop–livestock systems in the Sahel

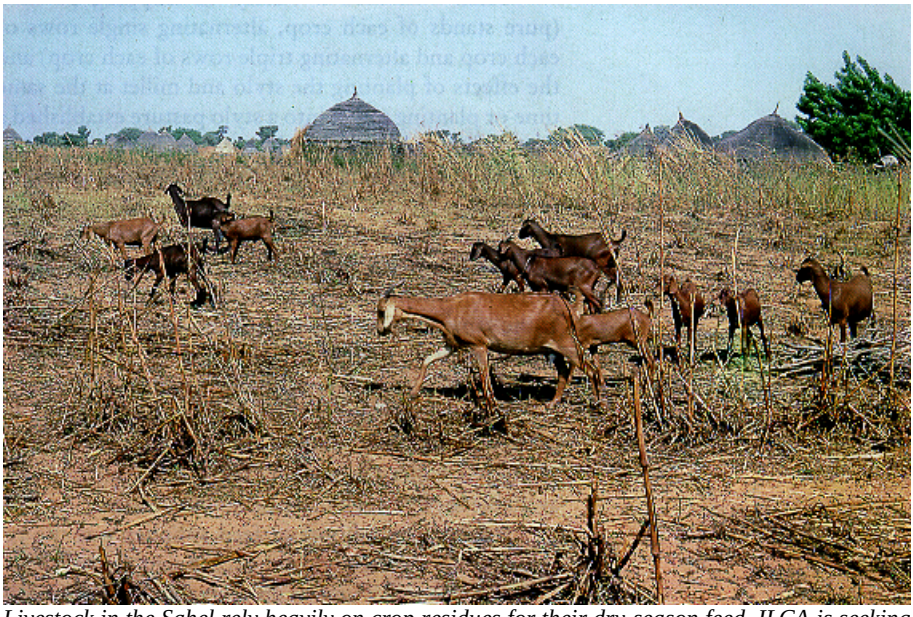
The cropping systems of the Sahelian zone are based on cereals, primarily sorghum and millet. The soils of the zone are already poor in nutrients. Continued cereal cropping is further draining nutrients from the soil, harming soil structure, reducing yields and increasing the risk of environmental degradation.

Growing legumes — plants that, through their association with *Rhizobium* bacteria, are able to "fix" nitrogen from the air — helps restore the fertility of the soil and improve its structure, halting the decline in yields and increasing food security. Forage legumes also hold out the promise of

increased and improved supplies of feed for livestock, including the Sahelian zone's huge flocks of small ruminants.

During the dry season, many of the Sahel's sheep and goats rely on crop residues — particularly millet and sorghum stover — for most of their food. Trials in Niger in 1990 demonstrated the benefits of feeding growing sheep millet stover supplemented with cowpea hay or hay made from *Stylosanthes fruticosa*, a forage legume. Sheep fed only millet stover — the farmers' practice — gained less than 1 kg over the 70-day trial. Those fed an additional 500 g of stylo hay daily gained nearly 3.5 kg, while those receiving 300 g of cowpea hay a day gained 3.6 kg.

The benefits to livestock of growing legumes are thus clear, but Sahelian farmers are reluctant to devote land simply to forage production. Their crops must also be seen to benefit.



Livestock in the Sahel rely heavily on crop residues for their dry-season feed. ILCA is seeking ways to incorporate forage legumes into cropping systems to improve livestock feeding and increase the sustainability of the farming system as a whole.

Intercropping — benefits to crops and livestock?

Starting in 1989, ILCA scientists based at the ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Sahelian Centre, at Sadoré, Niger, have been examining possibilities for intercropping millet *(Pennisetum glaucum* [L.] R.Br.) with a local line of *Stylosanthes fruticosa* and an Australian cultivar of *S. hamata*, Verano.

Trials examined a variety of cropping patterns (pure stands of each crop, alternating single rows of each crop and alternating triple rows of each crop) and the effects of planting the stylo and millet at the same time or planting millet into a stylo pasture established a year earlier. Additional trials were conducted in 1990 to determine the residual effects of the various cropping patterns.

Millet grown in association with stylo gave much lower grain yields than millet grown alone — in the worst combinations giving half the yield when planted at the same time, as low as one-fifth when planted into a year-old stylo pasture.

But the picture is not entirely negative. Millet/stylo intercrops gave biomass yields similar to those of millet in pure stand but crude-protein yields up to four times as high as millet on its own. Thus, the quality of feed available for livestock increased dramatically.

Added to the boost in feed supplies was the residual effect of the stylo on subsequent millet yields. In 1990, sole millet grown on plots that had previously been under stylo for one or two years yielded up to half a tonne more grain than millet that followed millet (1.41 vs 0.90 t/ha). This is equivalent to the increase that would be obtained from applying up to 30 kg of fertiliser nitrogen per hectare, and compensated for the loss of grain yield in the intercrops.

The results of these trials hold out promise for the development of sustainable food and feed production in the crop–livestock farming systems of the Sahel. However, given the highly variable environment, further studies are needed, especially into ways to minimise competition between the cereals and forage legumes in intercropping systems.

Fodder banks boost farm productivity

ILCA originally proposed fodder banks — small, densely planted pastures of the forage legume, *Stylosanthes* — as a source of dry-season feed for cattle in Nigeria's subhumid zone. But, as is common elsewhere, more farmers in this zone own small ruminants than own cattle (70% vs 30%).

One of the problems farmers face is what to do with their sheep and goats during the cropping season. For most of the year, small ruminants are allowed to roam freely, foraging for themselves. But during the cropping season their movement has to be restricted to prevent them from damaging crops. Commonly, this has meant tethering them on natural pastures.

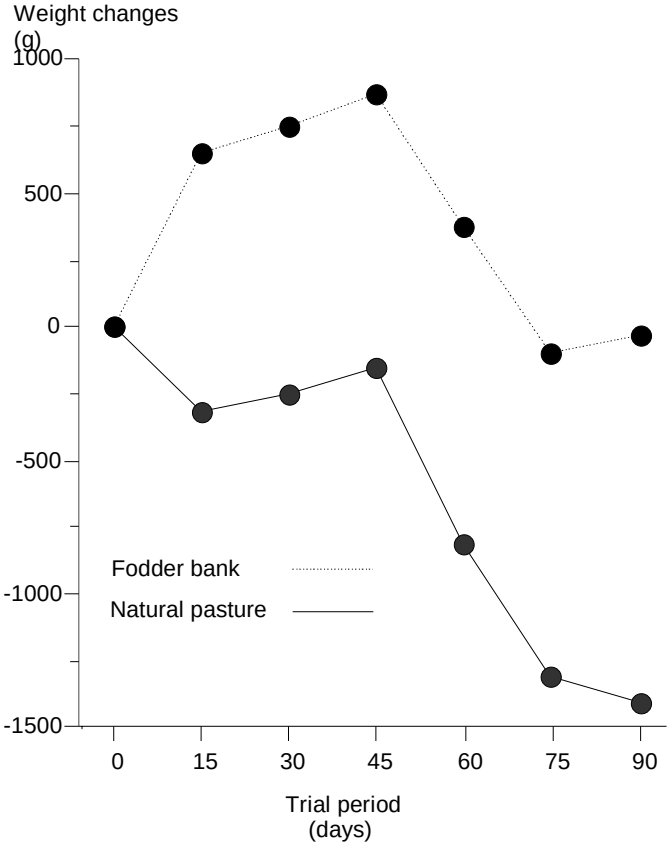
Increasingly, farmers in northern Nigeria are establishing fodder banks and confining their small ruminants on these legume pastures during the wet season. This represents a radical departure from the original concept of the fodder banks as a source of dry-season feed for cattle, in both species and time of use. ILCA has been monitoring farmers' practices since 1989 to evaluate this new use and determine if further research may be needed in support of the farmers' initiative. The practices compared include tethering goats on natural pasture, free-range grazing on enclosed natural pasture and free-range grazing on fodder banks.

Animals benefit, but crops benefit more

Surprisingly, wet-season management did not significantly affect survival of kids up to one year old, nor did it affect the kids' weight gains. Fodder-bank grazing did, however, significantly ($P<0.05$) reduce the amount of weight does lost during the wet season, from 46 to 34 g a day. All the animals lost weight towards the end of the wet season as the amount of feed available to them declined.

But more importantly, from the viewpoint of getting farmers to adopt fodder banks, crops grown on land that had been under stylo gave much higher grain yields than those that followed natural pasture. Maize yielded more than three times as much grain inside fodder banks as outside (1.7 ± 0.70 t/ha vs 0.5 ± 0.24 t/ha), while sorghum and millet yields almost doubled to 1.2 and 0.9 t/ha, respectively. Crop-residue yields also increased by similar amounts, an important consideration as residues form a large part of the dry-season diets of livestock in the zone.

Farmers in Nigeria's subhumid zone commonly tether their sheep and goats during the wet season to prevent them from damaging crops. ILCA is investigating the alternative of confining them to mini-fodder banks.



Goats on fodder banks lost a total of 50 g over the wet season — those on natural pasture lost nearly 1.5 kg.

Fodder banks offer considerable promise for stabilising agricultural systems in the subhumid zone. The crop yield increases stem from increased soil fertility together with improved soil structure and condition under the stylo pasture. Research in 1991 showed that the nitrogen content of the soil under stylo increased by up to 75% within two years (from 0.84–0.91 g N/kg under natural pasture to 1.1–1.48 g N/kg under the fodder banks). A range of soil characteristics showed marked improvements, including bulk density, organic-matter content, water-holding capacity and cation-exchange capacity. Boosting crop yields reduces pressure on crop lands, allowing for greater fallowing. The physical improvements in the soil increase infiltration of water during the rainy season, reducing run-off and risk of erosion and reversing the trend towards environmental degradation.

Towards better, sustainable farming systems

The studies in the Nigerian subhumid zone show what can be achieved by integrating crop and livestock production — benefits to people and their environment. Many farmers in the subhumid zone have already taken up fodder banks for use with cattle. Their extension to farmers with small ruminants promises wider benefits and more rapid uptake.

Prospects for the semi-arid zone are less obvious, but the needs are even more evident. ILCA's scientists continue their efforts to develop and spread improved, sustainable farming systems that meet the needs of Africa's rural people and their environments.

Animal Traction Thrust

Better management of agricultural soils is a key to both greater food production and protecting the environment. ILCA's work in the Ethiopian highlands focuses on helping farmers manage their land better using animal power. The initial target of the work has been Ethiopia's 8 million hectares of heavy, "black cotton soils" — Vertisols.

Vertisols are potentially highly productive soils. Unfortunately, in wet areas that potential remains locked up by their tendency to waterlog easily. Farmers have only a short time at the beginning of the rains to plough their land before it becomes too wet to work. Most crops cannot tolerate long periods with their roots under water, so farmers have to grow only those crops that do tolerate waterlogging or must wait for their land to dry out after the rains before planting other crops. Either way, the amount of food they can produce will be limited — waterlogging-tolerant crops tend to be low-yielding, while planting late in the rainy season reduces the amount of time and moisture available to the crop.

Since 1986 ILCA has been working to increase the productivity of Ethiopia's Vertisols through the joint Vertisols Project.[1] Bringing together three international organisations and several national bodies, the JVP has been a truly interdisciplinary project addressing all aspects of the use and management of Vertisols.

1. This project involves the Institute of Agricultural Research, Alemaya University of Agriculture, the Ministry of Agriculture, Addis Ababa University and the Relief and Rehabilitation Commission, Ethiopia; ICRISAT (the International Crops Research Institute for the Semi-Arid Tropics), India; IBSRAM (the International Board for Soil Research and Management), Thailand; and ILCA.

Broadbeds and furrows — the key to sustainable Vertisol use

ILCA's particular contribution has been the development of an animal-drawn broadbed maker. This is based on two local ploughs — *mareshas* — linked together. Attachments transform the simple, earth-breaking *maresha* into a land-shaping tool that can be used to form raised beds with shallow drainage ditches between them — broadbeds and furrows.

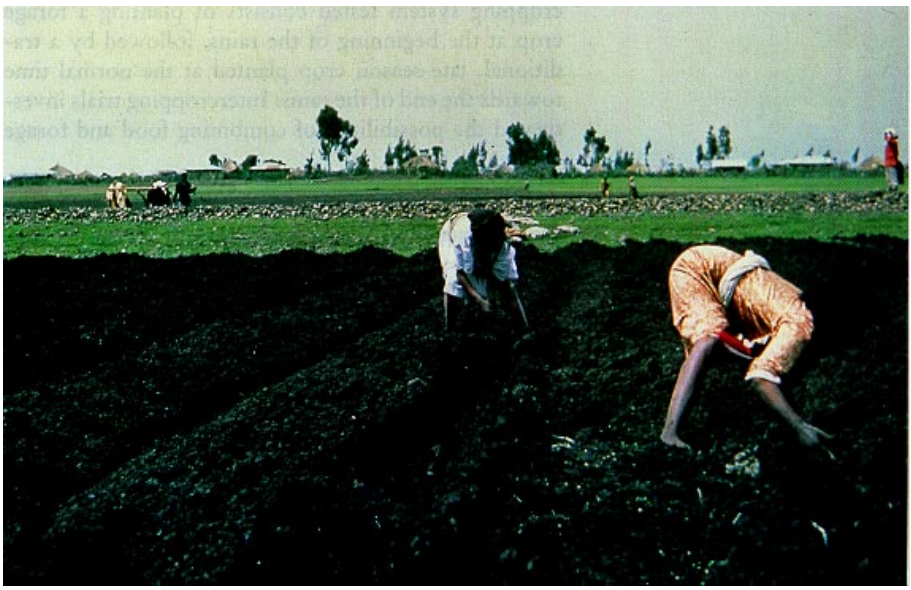
Raising the seedbed prevents waterlogging in the rooting zone early in the season, and the drainage ditches help remove excess water. By eliminating waterlogging, the broadbed-and-furrow system allows farmers to plant crops earlier in the rainy season. This opens the way either for growing one crop of a higher-yielding variety that does not tolerate waterlogging, or for growing several crops within a growing season. Either strategy makes better use of land resources than do current practices.

In some parts of the Ethiopian highlands, farmers traditionally prepared broadbeds and furrows by hand. This back-breaking work, commonly performed by women and children, can be done faster and better using the broadbed maker. Making broadbeds with the broadbed maker takes about 16 hours per hectare; forming them by hand takes 60 hours. Altogether, land preparation, seeding and drainage take about 120 hours of work for each hectare in the traditional system, compared with about 75 hours using the broadbed maker. This gives a 40% increase in labour productivity, even if

yields remain the same. But results suggest that using the broadbed maker gives higher yields, possibly because the resultant broadbeds and furrows are more uniform than those made by hand.

The benefits to crops of planting on raised beds is obvious here — the faba beans on the right are growing on broadbeds, those on the left are growing on the traditional flat seedbed

In a further development, project scientists have developed a range of tools that attach to the broadbed maker. These include a tine bar for minimum cultivation, allowing broadbeds made in the previous season to be re-used and facilitating interrow cultivation of row-planted crops. Studies in 1991 showed that, using the tine bar, farmers could plant a chickpea *(Cicer arietinum)* crop in only 14 hours a hectare, compared with 120 hours a hectare if they used conventional cultivation methods and made new broadbeds and furrows.



Women in the Ethiopian highlands making broadbeds and furrows by hand. The animal-drawn broadbed maker developed by ILCA and its partners in the joint Vertisols Project can free women from this drudgery.

Farmers seek new land-use systems

Farmers using the broadbed maker have recognised the potential of the broadbed-and-furrow system. Now they are seeking help in developing new, more productive land-use systems.

ILCA scientists are investigating two routes to increasing the productivity of Vertisol cropping in the Ethiopian highlands — sequential cropping and intercropping. In each case, ILCA's interest is in introducing forage crops into the cropping system to boost the availability and quality of feed for livestock.

Using the broadbed-and-furrow system, farmers can grow two crops during the main rains because they can plant earlier than on flat seedbeds. The sequential cropping system tested consists of planting a forage crop at the beginning of the rains, followed by a traditional, late-season crop planted at the normal time towards the end of the rains. Intercropping trials investigated the possibilities of combining food and forage crops.

Sequential cropping

In 1991, the early-season forage crops — oats in pure stand or mixed with vetch *(Vicia dasycarpa)* — yielded an average of nearly 4 tonnes of dry matter per hectare. Crude-protein yields averaged about 280 kg per hectare for oats alone and over 520 kg per hectare for the oat/vetch mixtures.

The sequential cropping system simply adds a forage crop to the traditional cropping system. The forage crop produced is thus almost pure gain to the system. Under the traditional system the land would have lain fallow during the time the forage crop is growing. Indeed, the forage crops add to the sustainability of the cropping system by reducing soil erosion — leaving the soil bare during the rains exposes it to droplet and run-off erosion.

Yields of the four traditional crops grown after the forage crops — chickpea, India pea *(Lathyrus sativus)* and two local durum wheat *(Triticum durum)* cultivars — were similar to those of crops that followed a fallow period.

The benefits to the farming system of sequential cropping are thus clear. Including an oat/vetch forage crop in the cropping system provides enough high quality feed to support a crossbred dairy cow producing an average of 4 kg of milk a day for up to 15 months.

Intercropping

Intercropping is another way of producing both food for people and feed for livestock. By combining food and feed crops on a single piece of land, productivity can be raised by making fuller use of rain that falls, plus feeding values of crop residues are enhanced by the companion forage crop.

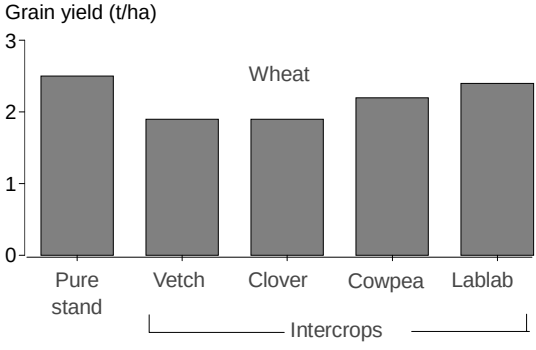
Trials in 1991 at ILCA's Debre Zeit research station tested four food crops — wheat and oats, commonly grown at medium to high altitudes, and maize and sorghum, which are medium- to low-altitude crops in pure stands and intercropped with lablab *(Lablab purpureus)*, clover *(Trifolium steudneri)*, cowpea *(Vigna unguiculata)* and vetch *(Vicia dasycarpa)*.

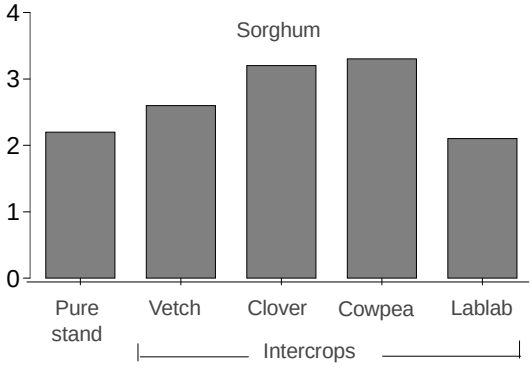
Sorghum performed best in intercrops, generally yielding more grain when intercropped than in pure stand. Oats grew well in combinations with vetch and lablab but gave markedly lower yields when grown with clover and cowpea. Maize did poorly in all intercropping combinations, losing nearly 50% of its grain yield when grown with vetch. Wheat grew

reasonably well in combination with the legumes, with only slight grain yield reductions.

In pure stands the cereals produced total feed yields (residues plus weeds) of between 7.3 and 8.8 tonnes of dry matter per hectare. Crude-protein yields ranged from 327 to 543 kg per hectare. Total feed yields of the intercrops ranged from about 8 tonnes to more than 11 tonnes of dry matter per hectare. Total crude-protein yields of the intercrops were almost double those of pure-stand cereals, ranging from 526 to 1099 kg per hectare, of which the cereals provided between 254 and 358 kg per hectare.

Wheat undersown with clover growing on broadbed. Intercropping food crops with forage legumes offers opportunities for increasing feed production while maintaining or increasing food production.





Sorghum did particularly well when intercropped with forage legumes, although wheat yields were only slightly depressed. Increased productivity of livestock from having more and better feed available should offset any negative effects in this mixed-farming system.

The increases in dry-matter and crude-protein yields from the most productive intercropping systems are similar to those from sequential cropping. In the best combinations — particularly sorghum with cowpea — cereal production increased at the same time as the feed available for livestock increased in both quantity and quality.

Sequential cropping or intercropping?

Both systems clearly boost the productivity of the highland Vertisol cropping system. The benefits of each are similar — more feed for livestock without compromising food-crop production, together with early establishment of plant cover to protect the soil during the rains. Early planting provides much-needed vegetative cover early in the rainy season. This protects the soil from water erosion and consequent nutrient losses. Under the traditional system the land is left bare until crops are planted late in the season.

Each cropping system would be a boon to farmers — but used in combination, they offer even more. Sequential cropping provides feed early in the wet season, while feed from intercropping becomes available later. Using a combination of the systems would thus boost feed production at different times, smoothing the pattern of feed availability, broadening the livestock production and land management options available to the farmer. For example, while fattening sheep for a particular market period requires feed over only a relatively short period, if a farmer is to keep dairy cattle he or she will need to produce adequate supplies of feed throughout the year. Sequential cropping helps achieve this.

Socio-economic sustainability

Technically, the broadbed-and-furrow system clearly works. But will farmers adopt it?

Studies in 1991 showed that farmers, once introduced to the broadbed maker and broadbed-and-furrow system, continue to use it without further intervention from ILCA and even teach other farmers in their areas to use the system.

Seventy-six farmers who had been using the broadbed maker under ILCA supervision up to 1990 continued to purchase inputs on credit and to use seed and fertiliser rates recommended by the Ministry of Agriculture. These farmers, at three sites in the Ethiopian highlands, also trained another 150 farmers in the use of the broadbed maker and the broadbed-and-furrow system.

Farmers using the broadbed-and-furrow system obtained wheat grain yields of nearly 1.8 tonnes per hectare at Ginchi, one of the three sites monitored. Yields from the traditional system were less than one tonne per hectare. Using the improved cropping system gave gross margins for wheat production nearly triple those for the traditional system (Ethiopian birr 1449 vs EB 536)[2] while net return per hectare more than tripled and return to labour more than doubled.

2. US$ 1 = EB 2.07.

Importantly, yields and gross margins obtained by farmers new to the broadbed-and-furrow system were similar to those obtained by experienced farmers (1776 vs 1793 kg/ha and EB 1454 vs EB 1489).

All these results suggest that the broadbed-and-furrow system is sustainable under farmer management, as long as inputs and credit are available when needed, and that farmer-to-farmer extension works. The prospects for widespread adoption of the broadbed-and-furrow system thus look good. Animal traction is the key that makes it possible.

Animal Feed Resources Thrust

Desertification — or land degradation as many now prefer to call it — has been a hot topic for several years, attracting much public attention. But in truth, relatively little is known about what causes desertification, how widespread the problem is and how much influence human activity has on it.

Long-term research by ILCA is beginning to answer some of these questions for the fragile environment in the Sahel region of Mali. Collaborative work with national programmes in the region is gathering pace and will increase the amount of information available on the extent of desertification and promote monitoring of future changes.

ILCA scientists have been monitoring rangeland productivity at some 25 sites in the Gourma region of Mali since 1984. Information is collected on above-ground biomass yield, plant cover and species composition, together with rainfall data. In 1991 these data were compiled and analysed.

Rainfall and biomass

Between 1984 and 1991, annual rainfall fluctuated widely, from a minimum of 158 mm (averaged across 24 sites) in 1987 to 326 mm in 1991 (Figure 1). Despite the wide fluctuations, annual rainfall appears to be increasing, offering the hope that the long period of drought that has affected the Gourma region since 1968 may be coming to an end.

ILCA's results clearly show the resilience of the Sahelian rangelands — annual biomass yields closely follow annual rainfall, even after the extended drought (Figure 1).

The effects of livestock and human pressure in the dry season — such as grazing, trampling and burning or during the growing season — e.g. heavy grazing — carry over into the following growing season. Trials were carried out in 1990 and 1991 at three sites to examine what effect trampling and burning the vegetation during the dry season would have on biomass yield in the following rainy season.

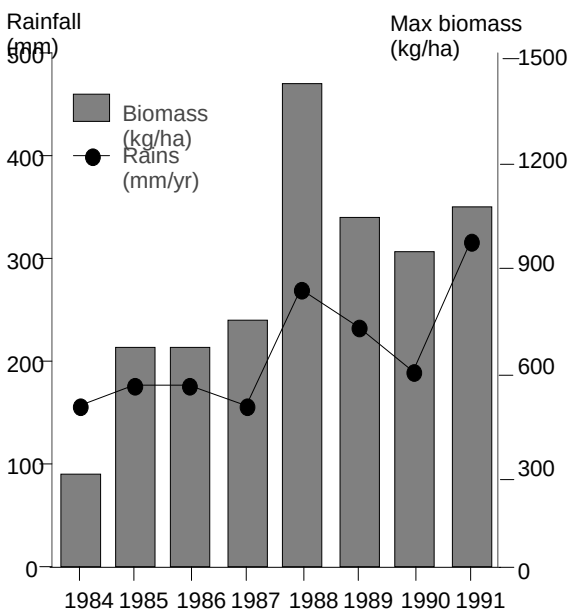


Figure *1. Rainfall in the Sahelian zone in Mali bas been increasing in recent years — as have range biomass yields.*

The trends observed were as might be expected. Yields in the following season were lower following trampling, and lower still following burning, than on the protected control plots, but the differences were not significant (Figure 2).

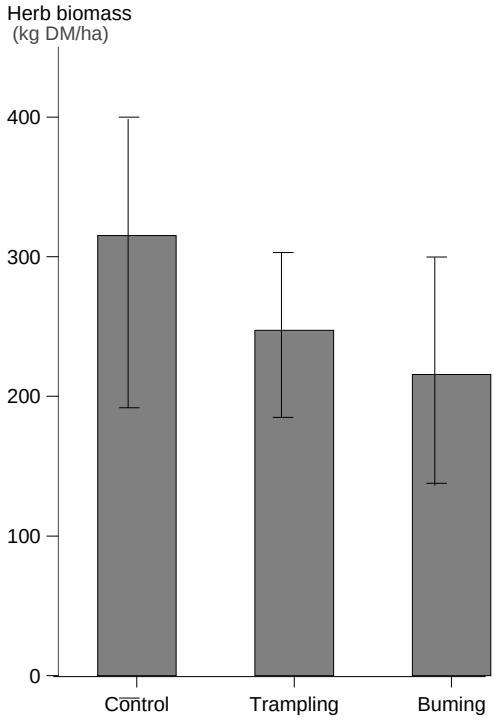


Figure *2. Trampling and burning appear to reduce range yields but high variability masks significance of the effect.*

A third treatment — short-duration grazing — was applied to plots adjacent to the trial at two contrasting sites, one an upland site (31) and one in a depression, which benefited from "run-on" water during the rainy season (site 20).

Again, trends were apparent in plant density and total plant cover. Both were lower in burned and grazed plots than in control and trampled plots. The effects of the treatments appeared to be larger on the upland site, where the vegetation was dominated by forbs, than on the "depression" site, where the vegetation was primarily grasses (Figure 3). On the upland site, grass density seemed to increase following burning, trampling and grazing as compared with the protected control plots.

Despite the large differences between treatment means, there were no significant differences between the treatments. This reflects the enormous variability inherent in the Sahelian rangelands and highlights one of the main difficulties in studying range trends and land degradation.

Rangeland resilience

The pasture grass, *Cenchrus biflorus*, has assumed increasing importance on sandy soils in the Sahelian rangelands over the long period of below-average rainfall since the late 1960s. In many parts of the Sahel, it now accounts for as much as 80% of the herbage biomass. ILCA has been looking into the mechanisms that have made this grass so successful and the implications these may have for livestock.

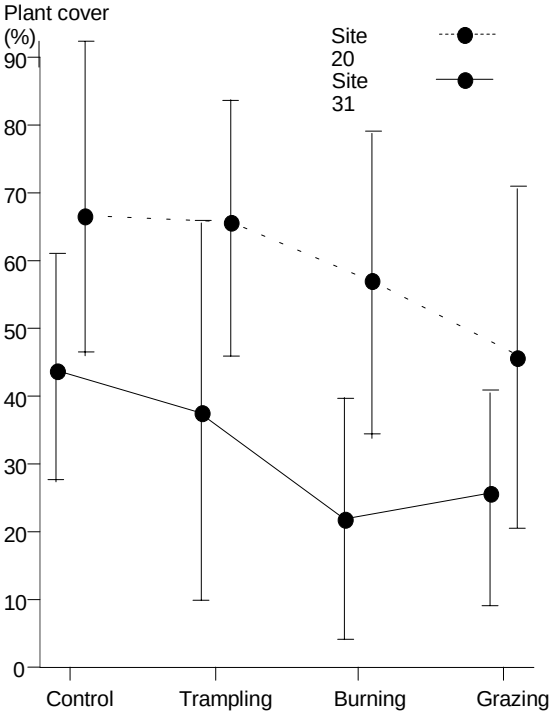


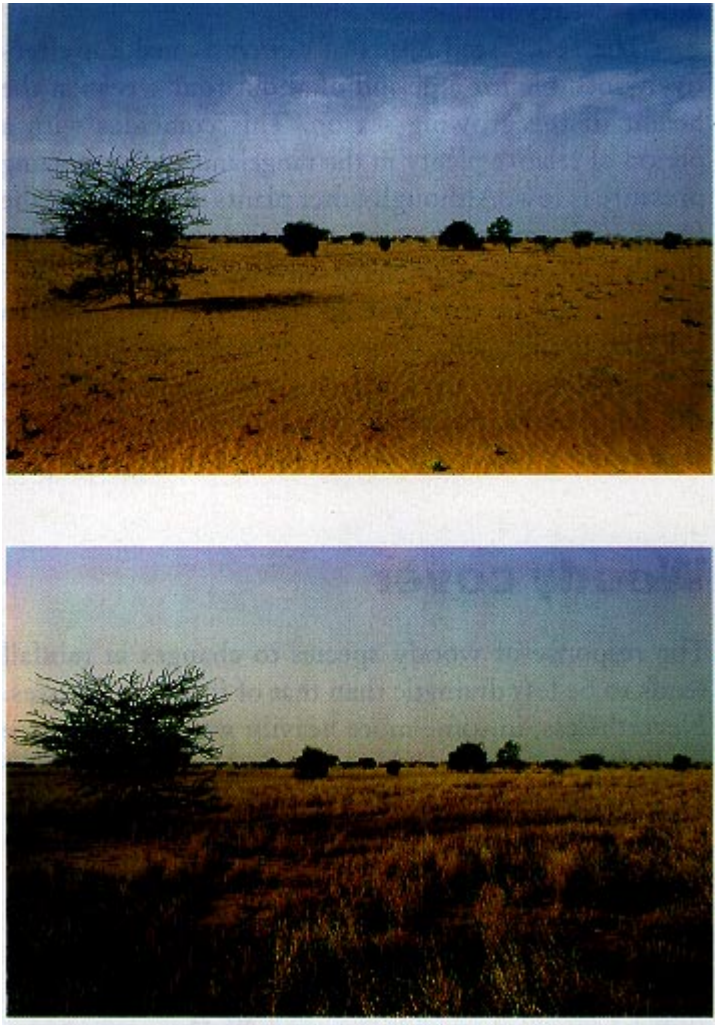
Figure 3. *Trampling, grazing and burning all appeared to reduce plant cover, especially where the predominant vegetation was broad-leaved plants. But again, high variability masked statistical significance.*

During the rainy seasons from 1987 to 1989, a 0.1 hectare plot of a range-type dominated by *Cenchrus biflorus* was subjected to light grazing and repeated cutting as the grass was flowering. This prevented effective flowering and drastically reduced seed set. Another 0.1 hectare plot was subjected to light grazing only. In 1991, the yield and species composition of both plots were examined.

The picture that emerges is one of superb adaptation of *Cenchrus biflorus* to its environment. The grass produces an extremely spiky seed head that livestock find unpalatable, leaving it alone until the seeds have dropped. Under normal conditions, the grass is able to seed profusely, rapidly building up the stocks of its seed in the soil.

Removing the plant's grazing defense mechanism — its spiky seed head — rapidly reduces its dominance in the pasture. In the repeatedly cut plot, *Cenchrus* produced a plant cover of only 5%, compared with 16% cover in the uncut plot. However, the biomass yields of the two plots were not significantly affected, the place of *Cenchrus* being taken by other grasses and forbs. Another characteristic of *Cenchrus* is its profuse tillering, rapidly establishing ground cover when conditions are favourable.

The spiky seed heads of *Cenchrus* make it effectively inedible for a period of about four weeks at the height of the growing season. This coincides with a period of relative plenty in the rangelands, when grazing pressure is low. Although other plants may become the focus of increased grazing attention while *Cenchrus* flowers, many species have already completed their growth cycle by this time and are thus better able to tolerate grazing than they would be during other periods. *Cenchrus* thus helps maintain the resilience of the rangelands, protecting the soil during the rainy season and avoiding the worst effects of overgrazing.



Range production varies enormously between years in the Sahel. The photographs show the same site in the Gourma area of Mali on 21 October 1987 (top) and 20 October 1989 (bottom) Studies of range trends have to be long-term to encompass extremes like these.

Woody cover

The response of woody species to changes in rainfall tends to be less dramatic than that of forbs and grasses. Nevertheless, in some more heavily wooded sites, tree cover fell by nearly half between 1984 and 1988 (Figure 4). Tree cover at these sites has since started to recover, the opening up of the canopy encouraging regeneration from seed and coppice regrowth.

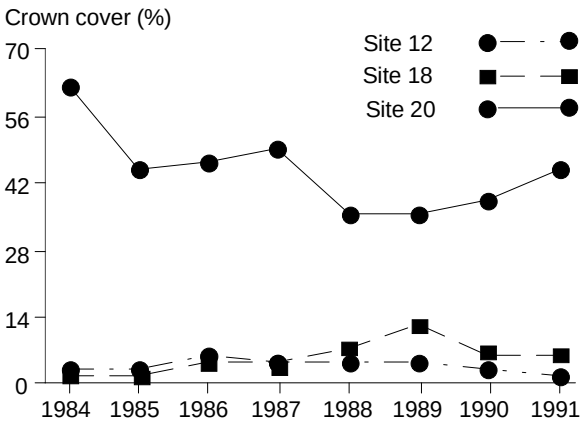


Figure 4. *Tree cover at three sites in the Gourma area of Mali. Losses were particularly dramatic in 1984 and 1987, years of severe drought.*

Tree leaf production varied widely between years, but was not directly linked with rainfall during the growing season. While 1988 was the best year for herbaceous growth, in terms of rainfall use efficiency, the density of tree foliage that year was lower than in 1989, probably due to a lag effect related to the slow replenishment of moisture in the deeper layers of the soil profile tapped by trees. However, current-season rainfall did affect the length of the growing period, as indicated by different rates of decline in green leaf density at the end of the season. In both 1990 and 1991 little rain fell after early September, in contrast to the more prolonged rains in 1988 and 1989 (Figure 5).

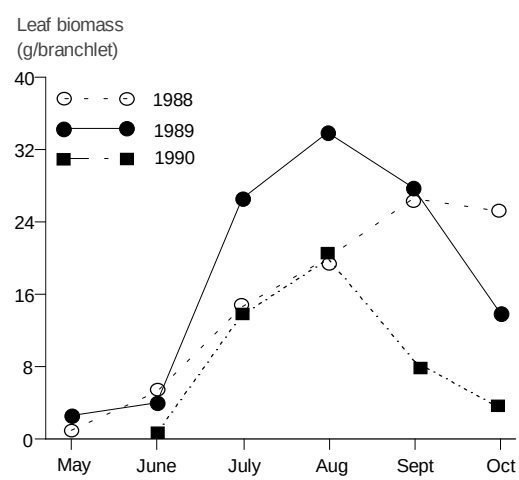


Figure 5. *Tree foliage growth in three contrasting year-types. Up to August, tree leaf biomass yield depends largely on rainfall in the previous year. Yields in September and October are influenced by current season rainfall. Rainfall was low in 1987, high in 1988 and low in 1989 and 1990. Hence 1988 saw low mid-season leaf biomass but continued growth in the late season; 1989 saw high August biomass yield but a rapid fall-off in the late season; and 1990 saw both low mid-season yield and early fall-off.*

Implications

ILCA's studies reveal a picture of ecosystems that are both more dynamic and more resilient than has often been assumed. Rangeland "degradation" is not a one-way process that can be determined from observations at isolated points in time. Rather, there is a process of constant change. Less palatable, unproductive plants may supplant palatable, more productive species for a time, but in doing so they may protect remaining reservoirs of seeds of the palatable species. In time, the more productive species may be able to re-establish themselves earlier than they might have if they had been subjected to continued grazing pressure.

There are no quick or easy answers in studying the dynamics of rangelands, especially in the highly variable environments of the Sahel. But ILCA's base of knowledge is growing, in partnership with colleagues in Africa's national programmes, providing a resource that will help better-informed decisions to be made concerning the future of the Sahelian rangelands.

Trypanotolerance Thrust

ILCA-coordinated research in 1991 was able to quantify for the first time the effects of trypanosome infections on the reproductive performance of N'Dama cattle exposed to high natural tsetse–trypanosomiasis challenge over their lifetimes. It also provided estimates of the superiority in reproductive performance of the animals identified as the most trypanotolerant among the N'Dama populations under study.

Trypanosomiasis, a disease transmitted by the tsetse fly, severely reduces the productivity of cattle in tsetse-infested areas. Trypanotolerant cattle, such as the N'Dama and West African Shorthorn, are able to survive and remain productive even under high trypanosomiasis risk. However, their productivity falls as disease risk increases, particularly if they are under stress. It is widely believed that this poorer performance under high disease risk is due to the effect of trypanosomiasis on reproductive performance.

But quantifying this effect is difficult because of the large number of observations needed and the length of the reproductive cycle of cattle. Weight changes, for example, can be measured over only a few months. A full calving cycle, from one calving to the next, may take several years and at least two calving intervals are needed for any meaningful productivity research. Yet reproductive performance is one of the prime determinants of the biological and economic efficiency of livestock production systems.

The African Trypanotolerant Livestock Network, coordinated by ILCA, is now in the unique position of having accumulated health and production data on large numbers of cattle over many years at several sites in tsetse-infested parts of Africa. In 1991, data from two of these sites, Mushie Ranch in Zaire and OGAPROV Ranch in Gabon, were analysed to elucidate the effects of trypanosome infections on reproductive performance.

Trypanotolerant N'Dama caattle in Guinea. Recent results show that improved trypanotolerance is linked with greater reproductive performance.

At Mushie Ranch, scientists record data each month on a variety of health aspects, including packed red cell volume (PCV, a measure of anaemia) and occurrence of parasitaemia (trypanosomes in the blood). They also monitor the reproductive performance of the same animals — in particular, the time they take to conceive again after calving — throughout their productive lives. Preliminary analyses in 1991 covered 186 cows and their progeny monitored between 1984 and 1990. Monthly records on the cows covered an average of five years. Over this period the cows had completed a total of 436 calving intervals.

A total of 1028 cow-year records were available from OGAPROV Ranch in 1991. These records were for 260 N'Dama cows, each of which had matching health and production records covering at least two years. In addition, 458 records covered calf-dam pairs in which the calf had survived to weaning, and for which monthly health and production records were available for both the cow and the calf and the dam had weaned at least two calves.

Trypanotolerance boosts reproductive performance

Trypanotolerance is characterised by the ability of an animal to limit the degree of anaemia caused by a trypanosome infection or to control the development of the parasites.

The results from both sites showed a clear link between an animal's level of trypanotolerance — as indicated by high PCVs when infected — and its reproductive performance.

In Zaire, animals able to maintain high PCVs had shorter calving intervals than those with low PCVS. Among cows infected twice by *Trypanosoma congolense* in the eight months after they had calved, time to conception decreased significantly by 15.3 days with each percentage-point increase (e.g. from 28% to 29%) in PCV.

In Gabon, calf weaning weights increased by 0.90 ± 0.39 kg for each percentage-point increase in average calf PCV and by 0.96 ± 0.39 kg for each percentage point increase in average cow PCV. Calving rate increased by 3.3 ± 0.65% with each percentage-point increase in average cow PCV.

The number and species of trypanosome infections also had a marked effect on animal responses at both sites. In Zaire, trypanosome infection had a significant effect on time to conception only when cows were infected twice with *T. congolense* in the eight months after calving. Single *T. congolense* or *T. vivax* infections had no significant effects on time to conception. Cows infected twice with *T. congolense* conceived again nearly two months later than cows that remained free from trypanosomes (212 ± 22.4 vs 156 ± 16.1 days). In Gabon, only *T. congolense* had a significant effect on calving rate. *Trypanosoma vivax* infections did reduce calf weaning weight, but by less than *T. congolense* infections.

These results demonstrate, for the first time, the magnitude of the effects of trypanosome infections on reproductive performance under high natural tsetse–trypanosomiasis challenge. They again demonstrate the benefits of trypanotolerant cattle in tsetse-infested areas, not only in terms of short-term productivity, such as weight gain, but also through their greater lifetime productivity.

Better feeding boosts lifetime performance through better disease resistance

Studies in The Gambia have demonstrated that better feeding helps trypanotolerant cattle reduce the effects of trypanosome infections.

Results from The Gambia show that better feeding boosts trypanotolerance in N'Dama bulls.

In 1990, a group of N'Dama bulls infected with *Trypanosoma congolense* were fed either well or poorly and their response to the disease was monitored. All the animals became increasingly anaemic once the parasites appeared in the blood: PCV levels declined linearly, reaching a minimum 24 days later. But feeding level had a marked effect on both how fast PCV fell and the minimum level reached. PCV fell significantly more slowly in well-fed animals than in poorly fed animals (0.199 vs 0.273 units per day; $P<0.01$). Well-fed animals also maintained a higher level of PCV during the four weeks after the initial decline in PCV had halted (21.1 vs 19.8%; $P<0.01$).

In 1991, results from a series of feeding trials were collated and analysed. These clearly demonstrated that, while supplementing the diets of heifers and lactating cows is worthwhile, the effects of supplementary feeding on calf performance are small and only temporary.

The results showed that the lifetime reproductive performance of N'Dama cows can be raised by feeding heifers better for a short period. Supplementing N'Dama heifers grazing natural pastures with groundnut cake during the late dry season and early wet season markedly increased weight gain during both the dry and the wet season and significantly increased conception rates and subsequent calving rates. Together, these effects mean that heifers may calve up to a year earlier than they might have if not supplemented. Groundnut cake is readily available in The Gambia and supplementary feeding is both practical and economically sustainable.

Supplementing the diets of lactating cows in the village system had large benefits for milk production and reproductive performance. In a series of trials in three villages, feeding cows 1 kg of cottonseed a day in addition to normal grazing during the dry season increased milk offtake for human consumption by 60%, from 52.8 to 86.1 litres, and reduced cow weight losses by 40%, from 34.8 to 24.9 kg.

In a second set of trials, cows fed 90 kg of sesame seed cake over the dry season — either 1 kg a day from January to March, or 1 kg a day from April to June, or 0.5 kg a day from January to June — performed significantly better than unsupplemented cows, irrespective of the supplementation scheme. Supplementation increased milk offtake by 70% (from 69 to 121 litres), reduced cow liveweight losses by 34% (from 41.8 to 27.4 kg) and increased calf weight gain by 90% (from 13.9 to 26.3 kg). Providing the supplement at the lower rate over six months gave the best results; 64% of cows on this feeding regime calved again within two years, while only 19% of unsupplemented cows did so.

The combined results of the oilseed feeding trials showed that each kilogram of supplementary crude protein fed produces an extra kilogram of milk and an extra 250 g of calf liveweight and reduces cow liveweight losses by 380 g.

Benefits of trypanotolerance reaffirmed

Trypanotolerant cattle clearly have advantages over non-trypanotolerant cattle in tsetse-infested areas. Not only is their productive performance better, but latest results demonstrate clear superiority in reproductive performance when infected. Importantly, the results demonstrate that the reproductive performance of the most trypanotolerant animals is markedly superior to that of less trypanotolerant animals in the same populations.

Livestock Policy Thrust

In recent years there has been a growing general awareness of the importance of "policy" to agricultural development. Without policies that favour agricultural production, no amount of agricultural research will lead to marked increases in food production or to sustainable use of natural resources.

ILCA has had an active policy research programme since 1986. This has emphasised not only ILCA's own research, but also services to policy makers. Well-trained and well-informed policy analysts are the key to the development of appropriate national policies in the livestock sector. The Centre has run training courses for policy makers from African government agencies each year since 1986; the course in 1991 was conducted in French for policy makers from francophone West Africa. In 1991, as part of its effort to provide information to assist policy-making, ILCA published a handbook of African livestock statistics.

Focus on the future

In the latter part of the year, the focus of the Thrust was on assessment of priority activities for the future. This led to the convening of a "Planning Workshop on Livestock and Resource Management Policy" in early 1992, which brought together experienced policy researchers to identify issues for policy analysis and discuss priorities in training and research, where ILCA's comparative advantage lies and with whom it should collaborate.

The workshop was attended by NARS (national agricultural research systems) representatives from Côte d'Ivoire, Ethiopia, Kenya and Zimbabwe, and representatives of the International Food Policy Research Institute (IFPRI), Utah State University, USA, the University of Wisconsin–Madison, USA, the Australian Bureau of Agriculture, the United Nations Economic Commission for Africa (ECA), the Danish International Development Agency (DANIDA), Winrock International, USA, and the World Bank.

Participants identified a number of research priorities in the areas of resource management, trade and macro-economics and technology policy, markets and institutions. A particular feature of the workshop was the strong ILCA commitment to collaboration with other international agencies, in particular with IFPRI and ECA, and with NARS in addressing policy issues. Other potential collaborators identified by the meeting include the International Institute for Environment and Development and its network of African researchers, the African Centre for Technology Studies in Nairobi, Kenya, other CGIAR (Consultative Group on International Agricultural Research) centres in Africa and other institutes and universities throughout the world.

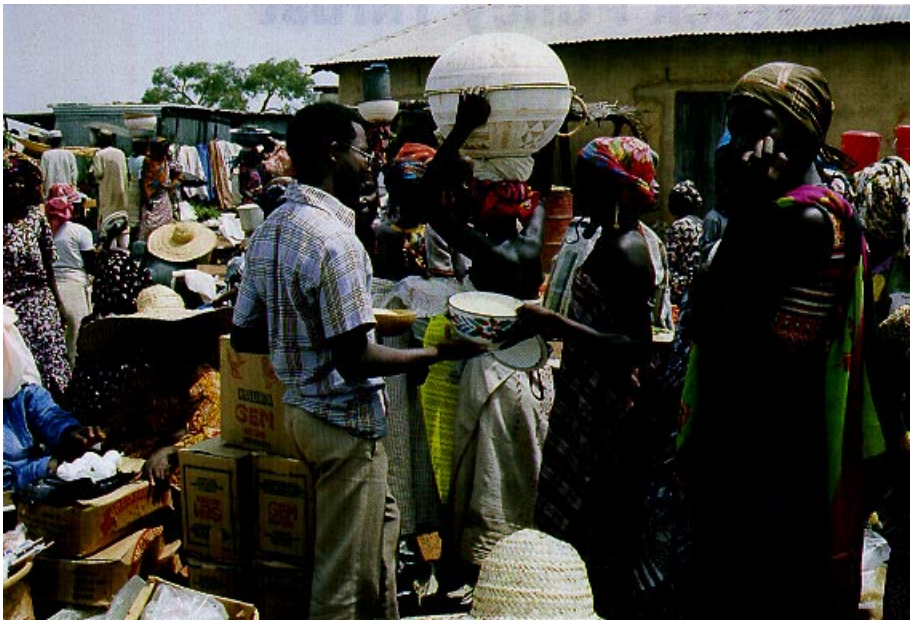
Livestock statistics

In 1991 ILCA published A *Handbook of African Livestock Statistics* as part of its effort to provide African policy makers with the information they need. The Handbook provides data on:

- livestock populations and their changes
- meat and milk production

- trade in livestock products
- consumption and food supply
- prices
- animal health services and
- land, human populations and economic factors.

The Handbook brings together for the first time, in direct and usable form, information that is otherwise dispersed among a wide range of sources and hence difficult to gather and use. It serves as a practical data base that will be of use to planners, analysts and policy makers in African NARS and international and donor organisations concerned with the performance of the livestock sector in Africa.



A market in northern Nigeria. Policies that encourage trade in livestock products are a key to increased livestock production.

The data in the Handbook offer some cause for concern. For example, growth rate in cattle populations showed a marked decline between 1961–74 and 1975–87, falling from 1.8 to 1.3% a year for sub-Saharan Africa as a whole. Annual growth rate in average milk yields per cow milked changed little over the period (1.1 and 1.2% a year), with an average annual yield of only 300 kg per cow in 1987 — less than half the average for the developing world as a whole (754 kg).

Overall, the message that emerges from the statistics is that there is room for substantial increases in livestock productivity in sub-Saharan Africa. Productivity levels are much lower in sub-Saharan Africa than in other parts of the world and are growing only slowly, if at all. Coupled with Africa's rapidly rising human population, this means that livestock production per person is falling. Urgent efforts are needed to boost production, and better policies are a key element in this effort.

Socio-economic research for better targeting of interventions

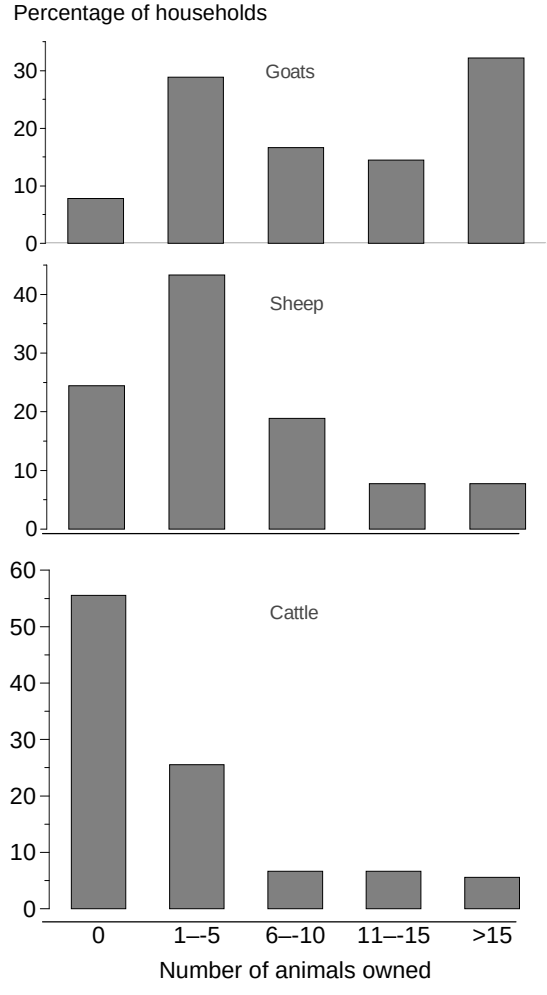
Research aimed at boosting small ruminant production in the Sahel could selectively benefit women, ILCA research in Niger shows. Between 60 and 70% of ruminants in small villages in drier areas were owned by women, the study found, whereas almost all the cattle were owned by men.

In the Sahel, farmers commonly accumulate livestock as a store of wealth that can be realised when they need cash or when their crops fail. Patterns of acquisition vary markedly, however. Understanding the reasons underlying these differences will help refine the targeting of research and interventions to specific types of producer.

Small ruminants in Niger. Targeting research to small ruminants should selectively benefit women, who own most of the small ruminants.

Data from a 1991 survey of three villages in Niger suggest that small ruminants — particularly goats — are increasingly important in these Sahelian farming systems. Comparisons with previous data for the two villages in the drier zone (350 to 400 mm annual rainfall) indicate that, in replacing animals lost during the droughts of the mid-1980s, farmers are acquiring small ruminants rather than cattle.

In 1991, fewer than half the farm households kept cattle (44%), while almost all households kept goats (93%). Almost all livestock bought between May and July 1991 were goats. Significantly, almost half of all the animals bought were purchased as breeding stock, a clear indication of efforts to develop livestock holdings in the long term. Nearly a third of the sample households (32%) kept more than 15 goats, while fewer than 8% of households had more than 15 sheep and only 5% of households kept more than 15 cattle.



More people own small ruminants than own cattle in the Niger villages studied.

While these are only preliminary results, there are already clear implications for research in this zone. Research aimed at raising the productivity of small ruminants, particularly goats, will have potential impact for a broad section of the farm population, especially women. The apparent intention of farmers to build up their small ruminant flocks reinforces the need to find ways of integrating crop and livestock production in the Sahelian zone.

This work in Niger is just one element of the socio-economic research that underpins ILCA's research programme. Several other studies made considerable progress in 1991, including research into land tenure and alley farming, dairy marketing and the influence of credit on technology adoption. Important results from these and other projects will become available in 1992, continuing to guide ILCA's research towards meeting the needs of Africa's smallholder farmers.

Training and Information Department

Information is a key to development. A bald statement, but one that is true for all sectors of development, not just agriculture.

The Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR), in its "Review of CGIAR Priorities and Strategies", highlighted a continuing need for information provided through international efforts. The TAC report cites "global information services related to international strategic research on agriculture, forestry and fisheries" as one of four areas needing long-term international efforts. The others are in the fields of conserving and using genetic resources, conserving and managing natural resources and public policy and public management issues.

ILCA has been at the forefront of CGIAR efforts to provide information to agricultural researchers in the developing world. From 1991, the Centre is now in a position to be able to provide the full spectrum of information support activities for researchers in sub-Saharan Africa, from project development support to an outlet for research papers.

Project development — the first phase

The development of a new research proposal is the crucial phase in the life of a research project. It is the one step that determines the potential value of the output of the research. Lack of access to information at this stage can result in the researcher "re-inventing the wheel" expending scarce and valuable resources on studying a problem that has already been thoroughly researched elsewhere.

The first step in the life of a new research protocol should be a comprehensive review of literature on the proposed topic. ILCA's Information Services provide a range of services that help researchers plan their projects. These include bibliographies prepared by the Centre's scientists, in collaboration with information specialists in the Information Services, and retrospective searches of ILCA's data base and major international agricultural data bases. ILCA's library and bibliographic data base represent what is probably the world's most comprehensive collection of information on African animal agriculture — an immensely valuable resource for ILCA and its partners in African national programmes.

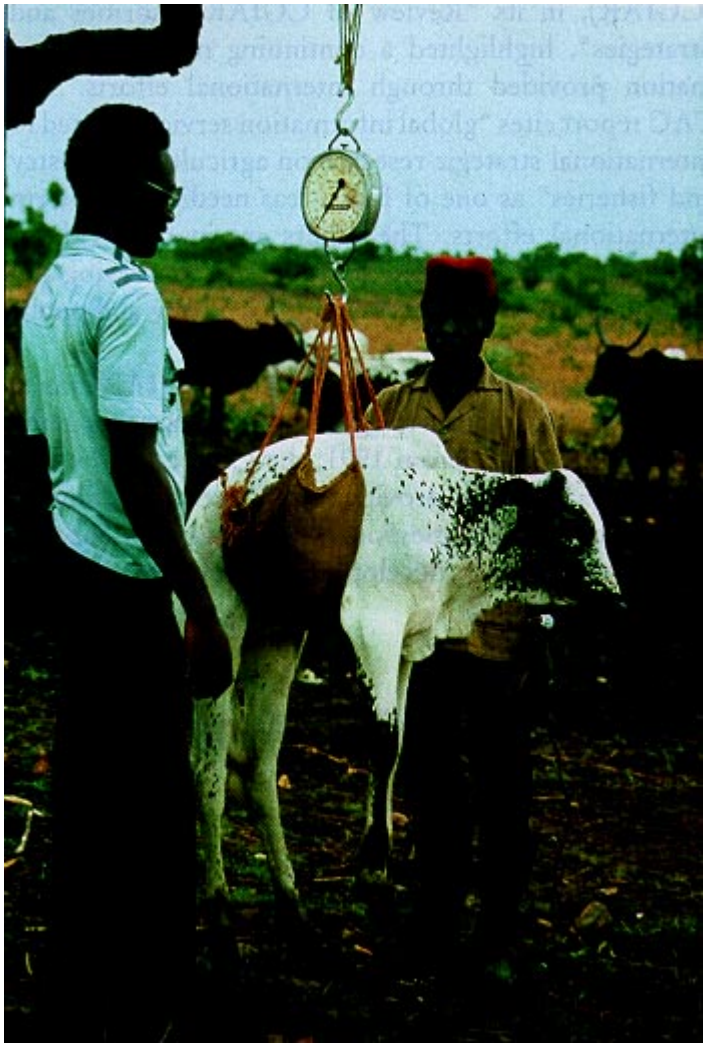
Bibliographies

Since 1985, ILCA has produced six specialised bibliographies covering:

- soils, fertilisers, plant nutrition and general agronomy in Ethiopia
- beef cattle production from tropical pastures
- *Gliricidia sepium*
- land and tree tenure in humid West Africa
- production and processing of milk from cattle in sub-Saharan Africa and
- animal traction.

The first two bibliographies produced (including an early animal traction bibliography) were less useful than they might have been, consisting of simple listings of publications on the topics concerned. Such listings are of relatively little use unless the reader has access to a library that has the

publications listed. This is generally not the case for ILCA's main target audience, researchers in sub-Saharan Africa.



An interesting piece of research, maybe — but has someone done it before? ILCA's Information Services can provide the answer, reducing overlap of research efforts and saving scarce resources.

Since late 1985, all ILCA bibliographies have been annotated — each entry is accompanied by an abstract. This way the reader can quickly gather what is known about a particular topic and can judge which of the publications listed might be of greatest use to him or her.

In a further development, the most recent bibliography, on animal traction, has been produced as both a printed book and as a computer data base. Thus, researchers who have access to a microcomputer can quickly and easily search the data base, but the information is still readily accessible to those who do not have a microcomputer. Increasingly, this is the path ILCA will follow in developing new bibliographies.

Preparing to search CAB Abstracts on CD–ROM. Retrospective searches use a range of information sources, including major international data bases available on CD –ROM.

Retrospective searches

The bibliographies produced so far by ILCA cover a wide range of topics, but are not exhaustive. There will always be subject areas not covered by them, and this is where ILCA's search service has a role to play.

Researchers who need information on a particular subject not covered by one of ILCA's bibliographies can send a request for information to ILCA's Information Services. Framed as a detailed description of the area of interest, this request is transformed into a search profile by ILCA's information specialists. Using this search profile, searches are initially made on ILCA's in-house data base, which held 65185 records at the end of 1991, and the data bases the ILCA Library has on CD–ROM (Compact Disk–Read-Only Memory) and the Centre's minicomputer. These include the following:

- CABI (Commonwealth Agricultural Bureaux International) Abstracts data base, 1984–91
- AGRIS data base of the Food and Agriculture Organization of the United Nations (FAO), 1977–91
- AGRICOLA data base of the US National Agricultural Library; contains over 2.9 million records covering the period 1970 to date and
- SESAME data base produced by CIRAD (Centre de co-opération internationale en recherche agronomique pour le développement), France.

The results of the searches, in the form of printouts listing the publications identified and their abstracts, are sent to the requester. The requester can then identify those items that are of greatest interest to him or her and can request photocopies of up to 30 pages of the items listed from ILCA's data base.

Together, bibliographies and retrospective literature searches provide a sound basis for planning a new project.

SDI — keeping up to date

Information is not static — the base of knowledge in any field is constantly growing as new results are published. Keeping abreast of developments in one's field is never easy, but for many researchers in Africa's national

agricultural research systems (NARS) the problem is compounded by lack of access to recent publications.

ILCA started its SDI — selective dissemination of information — service in January 1983. The SDI service operates by comparing users' "search profiles" — lists of key words and other indicators of the research interests of the users — each month with updates of the CAB Abstracts and AGRIS data bases. The computer automatically selects those records that match with the particular user's search profile. A print-out of the resultant search is sent to the user, who can then select those records of particular interest and request photocopies of the documents.

By 1990, more than 1000 scientists in African NARS were receiving ILCA's SDI service. During that year, a major review of the usefulness of the SDI service was conducted as part of a project funded by the International Development Research Centre (IDRC) of Canada. This, together with ILCA's past experience, led to the development of a new information policy. This includes:

- integrating the CAB Abstracts and AGRIS records with local input, which includes "grey literature" collected by ILCA
- restricting the service to areas central to ILCA's mandate. i.e. animal agriculture and closely allied fields
- building in a feedback mechanism to ensure that the service continues to meet users' needs
- providing an efficient document delivery service
- adopting a name for the service — ILCAlerts — and designing a new ILCAlerts form that helps the user describe his or her research interests in a way that will ensure best use from the service.

ILCAlerts started operating in June 1991, providing monthly updates to 93 researchers in sub-Saharan Africa. The number of recipients had risen to 169 by the end of 1991, with another 100 requests under consideration. In the service's first five months of operation, ILCAlerts recipients requested copies of a total of 764 articles, clearly demonstrating the need for such an information delivery system in Africa.

Publication — the final step

The final step in the research process is for the scientist to write up and publish his or her findings. Since late 1991, ILCA is supporting one outlet for primary research papers in the field of livestock research in sub-Saharan Africa — the new journal, *African Livestock Research.*

African Livestock Research grew out of a recommendation made at the Fourth Biennial Meeting between ILCA and Leaders of Livestock Research, Development and Training in Addis Ababa, Ethiopia, in July 1987. At that meeting, NARS leaders expressed the opinion that there was a need for an internationally refereed journal catering to the field of livestock research in Africa. The *ILCA Bulletin,* which ILCA was publishing at that time, was seen to be too closely identified with ILCA to be considered an important publications outlet for African scientists.

ILCA conducted an investigation of the livestock-related journals being published in Africa and of other possible outlets for papers relating to livestock research in the continent. This showed that most of the journals published in Africa were facing difficulties, commonly associated with shortage of foreign exchange, and authors faced long delays in publication. African authors also faced difficulties getting their work published elsewhere, again often associated with shortage of foreign exchange. And,

furthermore, while publishing in journals published in the developed world has personal prestige value, the results would remain largely unknown in Africa because few libraries on the continent have funds to subscribe to international journals.

Based on these findings, ILCA embarked on the process of establishing a new, internationally refereed journal. The announcement of the intended launch of the new journal attracted considerable interest and a large number of submissions. Early delays were faced in setting up a review process and editorial standards, but the first issue of the journal was published in late 1991, with a publication date of January 1992.

African Livestock Research is provided free of charge to 225 NARS libraries in sub-Saharan Africa and at a preferential subscription rate to NARS scientists in the region.

The first issue of the journal carried papers on animal traction in The Gambia, silage-making in Sudan and feeding trials from Zimbabwe and Nigeria, and short communications on plants poisonous to livestock in Swaziland and drug resistance in endoparasites in sheep in Nigeria.

By the end of 1991, the Editor of *African Livestock Research* had received a total of 148 papers, a clear indication of the interest in the journal. Of these, 29 were accepted for publication, 80 were returned to the authors for revision following review and 39 were rejected. A second issue was well into production by the end of 1991 and the journal is on target for the intended four issues in 1992.

A comprehensive information service to NARS

ILCA now provides a comprehensive information service to livestock researchers in sub-Saharan Africa. From initial surveys of what is known about a topic, through keeping researchers up to date on current knowledge, to publishing the results, ILCA offers a valuable, unique set of services. Through these services, the Centre hopes to ease the difficulties faced by researchers in Africa and promote the achievement of ILCA's goal of improving production from livestock in sub-Saharan Africa, to the benefit of the continent's people.

ILCA research protocols and programme activities, 1991

Cattle Milk and Meat Thrust

Reproductive wastage

Genetic conservation and improvement. of African cattle resources through the application of embryo transfer technology *(Ethiopia)*

Comparative study of the growth, reproductive development and function in zebu and crossbred bulls under different production and management systems *(Ethiopia)*

The effect of different growth rates on the onset of puberty, fertility and subsequent lactation and reproductive performance in heifers *(Ethiopia)*

The effect of nutrition and partial suckling and/or milking on the postpartum reproductive performance of zebu cows and on the growth performance of their calves *(Ethiopia)*

Effect of body condition after calving on the postpartum pituitary responsiveness to progesterone feedback in postpartum Ethiopian zebu and crossbred cows *(Ethiopia)*

Effect of wet season nutrition management on the gonadal function and sexual activity of cows and heifers in the tropics *(Ethiopia)*

The behavioural effects of varying doses of oestradiol benzoate in ovariectomised Small East African Zebu and crossbred cows *(Ethiopia)*

Estimation of disease risk to dairy cattle in coastal subhumid Kenya *(Kenya)*

Study of oestrous cycle and sexual behaviour on zebu mature cows *(Mali)*

Feeding and management systems

Effect of level of milk feeding and type of housing on the performance of crossbred dairy calves *(Ethiopia)*

Utilisation of sorghum stover by cattle: Effects of variety, level of offer and concentrate supplementation on intake, digestibility and growth of Boran and Boran × Friesian cattle *(Ethiopia)*

Development of feeding packages based on *Pennisetums* for smallholder dairy cattle *(Zimbabwe)*

The development of a feed-evaluation model for feed resources in sub-Saharan Africa using animal-response data, rumen studies and chemical analysis *(Ethiopia)*

Development of feeding and management systems for different classes of dairy cattle in the Ethiopian highlands *(Ethiopia)*

On-farm introduction of forage-based feeding packages for crossbred dairy cattle in the Ethiopian highlands *(Ethiopia)*

Feed resources for smallholder dairy production in coastal subhumid Kenya agronomic practices *(Kenya)*

Feed resources for smallholder dairy production in coastal subhumid Kenya — utilisation *(Kenya)*

Evaluation of seasonal availability of forages in villages around Bamako *(Mali)*

Determination of pasture intake by cattle on natural pastures *(Mali)*

Improvement of feed resources for increasing milk production around Bamako, Mali *(Mali)*

Peri-urban dairy production in the subhumid zone of Nigeria *(Nigeria)*

Optimal fodder bank utilisation for reproductive efficiency of Bunaji cattle *(Nigeria)*

Effect of wet-season supplementation on productivity of Bunaji cattle *(Nigeria)*

The effect of dry-season feeding of forage legumes on productivity of Bunaji cattle fed mineral supplements *(Nigeria)*

Evaluation of grass–legume mixtures for grazing and stall-fed cattle *(Nigeria)*

Evaluation of grass–legumes under oil palm *(Nigeria)*

Traditional cattle systems in the derived savannah and improved production systems *(Nigeria)*

Milk processing

Alternative milk processing and preservation techniques and the quality of market butter and cheese *(Ethiopia)*

Economics of cattle production

Consumption of and demand for beef and dairy products *(Ethiopia)*

Influence of socio-economic factors on technology development *(Ethiopia)*

Characterisation of coastal subhumid farming systems *(Kenya)*

Demand for and marketing of milk and dairy products in coastal Kenya *(Kenya)*

Strategies for improving the economic performance of dairy producers in the subhumid zone of Mali *(Mali)*

Identification of constraints of tenure practices **to** increased milk production in the subhumid zone of Mali *(Mali)*

Multilocational testing of fodder banks *(Nigeria)*

Socio-economic analysis of cattle production systems in the humid zone *(Nigeria)*

Breed evaluation and improvement

Development of an improved animal data management system *(Ethiopia)*

Evaluation of milk production in cattle breeds and crosses in small-scale herds in Ethiopia and Ghana *(Ethiopia and Ghana)*

Assistance to NARS in evaluation of cattle breeding programmes *(Ethiopia)*

Evaluation of the comparative health and performance of dairy cattle genotypes for smallholder production in the subhumid tropics *(Kenya)*

Network coordination

Cattle Collaborative Research Network *(ILCA and NARS)*

Small Ruminant Meat and Milk Thrust

Economics of small ruminant production

On-farm production and economic analyses of sheep-fattening strategies: Concentrate or forage supplementation *(Ethiopia)*

Analysis of the economic and socio-demographic factors affecting the demand for sheep in Ethiopia *(Ethiopia)*

Defining and measuring the sustainability of economic viability of alternative small ruminant production systems *(Ethiopia and Nigeria)*

Marketing and consumption of small ruminant products in the coastal subhumid zone of Kenya *(Kenya)*

Socio-economic analysis of alley farming with small ruminants *(Nigeria)*

Breed evaluation and improvement

Genetic variation in resistance to nematode endoparasitism in small ruminants *(Ethiopia and Kenya)*

Characterisation and evaluation of African small ruminant breeds *(Ethiopia, Togo and Tanzania)*

Performance evaluation of Ethiopian highland sheep breeds under varying management *(Ethiopia)*

Assessment of genetic resistance to gastro-intestinal parasites in small ruminants *(Kenya)*

Forage and feeding systems

Evaluation of feeds for use in feeding systems for small ruminants *(Ethiopia)*

The use of fodder from multipurpose trees as a source of protein in diets of small ruminants: Microbial metabolism of protein in the rumen *(Ethiopia)*

Mechanisms of protein and energy utilisation by ruminants fed diets made from low quality feedstuffs *(Ethiopia)*

Evaluation of feeds in the Sahel through intake and metabolism trials *(Niger)*

Introduction of forage legumes in Sahelian cropping systems *(Niger)*

Development of feeding systems for small ruminants in the Sahel *(Niger)*

On-farm wet-season supplementation of West African Dwarf goats in the subhumid zone of Nigeria *(Nigeria)*

Productivity of West African Dwarf goats on improved pasture in a mixed crop–livestock system in the subhumid zone of Nigeria *(Nigeria)*

Small ruminant feeding systems development for the humid zone *(Nigeria)*

Evaluation of MPTs in alley farm production systems *(Nigeria)*

Evaluation of productivity and nutritive values of local browse *(Nigeria)*

Reproductive wastage

Relationship between stage of supplementing pregnant ewes and perinatal lamb survival in Ethiopian Menz sheep *(Ethiopia)*

Fascioliasis and nutrition interaction in Menz sheep *(Ethiopia)*

Effect of hormone treatment on lamb output in Menz sheep *(Ethiopia)*

The effect of *T. vivax* infection on the metabolism and reproductive performance in West African Dwarf sheep *(Nigeria)*

Management systems

Evaluation of the contribution of crossbred goats to improved milk production and social welfare in smallholder mixed farming in medium-potential areas of sub-Saharan Africa *(Burundi)*

Constraint quantification in highland sheep production *(Ethiopia)*

Role and management of small ruminants alone or with cattle in the coastal subhumid zone, Kenya *(Kenya)*

Prospects for improving small ruminant production in farming systems of the humid zone *(Nigeria and Togo)*

Network coordination

African Small Ruminant Research Network (SRNET) *(ILCA and NARS)*

Animal Traction Thrust

Intensified/diversified use

Vertisol resource assessment, agroclimatology, crop modelling and water management *(Ethiopia)*

Land and water management: Animal-drawn implements for Vertisols *(Ethiopia)*

Land and water management: Land-shaping for water management and soil conservation *(Ethiopia)*

Cropping systems on drained Vertisols *(Ethiopia)*

Vertisol management in the Ethiopian highlands: On-farm technology verification *(Ethiopia)*

Introduction of traction

Comparative analysis of constraints to full utilisation of animal traction in Niger *(Niger)*

Draught animal power in inland valley *(fadama)* agriculture in the subhumid zone of Nigeria *(Nigeria)*

Feeding strategies

Effect of work on oxen of different body conditions *(Ethiopia)*

Alternative uses

Alternative uses of draught animals: Use of crossbred dairy cows for traction *(Ethiopia)*

Alternative uses of draught animals: Energy expenditure for work of draught crossbred dairy cows *(Ethiopia)*

Network coordination

Animal Traction Research Network *(ILCA and NARS)*

Animal Feed Resources Thrust

Services and resource assessment

The use of fodder from multipurpose trees as a source of protein in diets of small ruminants *(Ethiopia)*

Forage genetic resources *(Ethiopia)*

Legumes screening to low soil fertility and evaluation of rock phosphates *(Ethiopia)*

Forage seed production at the intermediate level *(Ethiopia)*

Resource assessment for forage technology development and transfer within ILCA mandate areas in West Africa *(West Africa)*

Feed resources evaluation

Rhizobium studies on forage legumes *(Ethiopia)*

Evaluation of MPT germplasm in coastal subhumid Kenya *(Kenya)*

Evaluation of grass and herbaceous species for coastal subhumid Kenya *(Kenya)*

Evaluation of forage legume genetic resources in the subhumid zone *(Nigeria)*

Nutritional requirements of forage legumes in the subhumid zone of Nigeria *(Nigeria)*

Multipurpose trees

Agronomic evaluation of accessions of multipurpose trees *(Ethiopia)*

Nutrient and water-use studies in tree–crop mixtures in the sandy soils of coastal subhumid Kenya *(Kenya)*

Initial evaluation of multipurpose trees *(Nigeria)*

Evaluation of MPTs in intensive feed gardens *(Nigeria)*

Legumes in mixed farm systems

Nutrient cycling (N) in legume-based crop–livestock systems *(Ethiopia)*

Legumes in mixed cropping systems: Role of forage legumes in nutrient cycling and soil surface management *(Nigeria)*

Network coordination

African Feed Resources Network (AFRNET) *(ILCA and NARS)*

Trypanotolerance Thrust

Trypanosomiasis epidemiology

Determination of the contribution that tsetse evaluation can make in predicting trypanosomiasis situations *(Côte d'Ivoire, Ethiopia, Gabon, Senegal, The Gambia and Zaire)*

Epidemiology of trypanosome resistance to trypanocidal drugs *(Côte d'Ivoire and Ethiopia)*

Factors affecting susceptibility to trypanosomiasis *(Senegal and The Gambia)*

Diagnosis of trypanosomiasis *(Gabon and Zaire)*

Trypanotolerance

Effect of trypanosomiasis on animal health and performance *(Côte d'Ivoire)*

Effect of trypanosomiasis on health and performance *(Senegal and The Gambia)*

Effect of trypanosomiasis on animal health and reproductive performance: Criteria of trypanotolerance and their linkage with reproductive performance *(Gabon and Zaire)*

Criteria of trypanotolerance and their linkage with animal growth *(Gabon and Zaire)*

Genetics of trypanotolerance

Genetic aspects of criteria of trypanotolerance and development of practical genetic improvement programmes *(Gabon and Zaire)*

Biological/economic evaluation

Biological and economic evaluation of productivity responses of trypanosusceptible livestock to alternative tsetse control methods *(Ethiopia)*

Biological and economic evaluation of productivity of N'Dama cattle in a *metayage* system under trypanosomiasis risk *(Zaire)*

Strategic nutritional supplementation *(Senegal and The Gambia)*

Economic evaluation of village cattle production under trypanosomiasis risk *(Côte d'Ivoire, Ethiopia, Kenya, The Gambia, Togo and Zaire)*

Livestock Policy and Resource Use Thrust

Policy services

Policy services *(Ethiopia)*

Policy research

The role of credit in promoting investment and the adoption of technology by smallholders in livestock development in sub-Saharan Africa *(multi-country)*

Workshop on livestock pricing policy *(Niger)*

Land tenure and alley farming in West Africa *(Cameroon, Nigeria and Togo)*

Range trends

Trends in range resource productivity and management in the Sahel *(Mali)*

Analysis of ecological processes in the Sahelian rangelands (Mali)

Development and testing of methods for the monitoring of resources in the Sahel *(Mali)*

Semi-arid livestock

Modelling economic outcomes of crop–livestock production systems in the Sahel *(Semi-arid West Africa)*

Nutrient cycling by ruminants in the Sahel *(Niger)*

Crop residue assessment in the Sahel *(Niger)*

Training and Information Department

Training programmes

Training materials and methods

Documentation

Publishing

Research collaborators, 1991

Africa

Burundi

Projet caprins de Ngozi

Cameroon

Institut de recherche zootechnique

Institut de recherche agronomique

Côte d'Ivoire

Société de développement des productions animales

Ethiopia

Addis Ababa University

Alemaya University of Agriculture

Institute of Agricultural Research

Ministry of Agriculture

Gabon

Office gabonais de production et d'amélioration de viande

The Gambia

Department of Livestock Services

Kenya

Kenya Agricultural Research Institute

Ministry of Livestock Development

National Dairy Development Programme

National Veterinary Research Centre, Muguga

University of Nairobi

Mali

Institut national de recherche zootechnique, forestière et hydrobiologique

Niger

Institut national de la recherche agronomique du Niger

University of Niamey

Nigeria

Ahmadu Bello University

Institute for Agricultural Research

Bauchi State Rural Development Authority

Calabar Polytechnic

Kaduna State Ministry of Agriculture

Kano Agriculture and Rural Development Authority

Katsina State Government

Michael Okpara College of Agriculture

National Animal Production Research Institute

National Livestock Projects Division

National Veterinary Research Institute

Obafemi Awolowo University

Rivers State University of Science and Technology

University of Agriculture, Makurdi

University of lbadan

Senegal

Institut sénégalais de recherches agricoles

Tanzania

Sokoine University of Agriculture

Tanzania Research Institute

Togo

Projet national petits ruminants

Projet pour la promotion de la traction animate

University of Benin

Zaire

Compagnie J Van Lancker

Développement progès populaire

Zimbabwe

Department of Research and Specialist Services

Outside Africa

Australia

University of Melbourne

Commonwealth Scientific and Industrial Research Organization

Canada

International Development Research Centre

Denmark

Danish Plant Directorate

Germany

Technical University of Berlin

University of Giessen

University of Göttingen

Italy

University of Milan

New Zealand

Massey University

Switzerland

University of Bern

The Netherlands

University of Utrecht

University of Wageningen

United Kingdom

Agriculture and Food Research Council, Institute of Engineering Research

Agriculture and Food Research Council, Institute for Grassland and Environmental Research

Agriculture and Food Research Council, Institute of Animal Physiology and Genetics Research

A P Consultants

Farm Africa

Natural Resources Institute

Overseas Development Administration

Rowett Research Institute

University of Aberdeen

University of Glasgow

University of Reading

United States of America

Louisiana State University

Texas A&M University

University of Florida

University of Wisconsin–Madison

Winrock International Institute for Agricultural Development

International organisations

Centro Internacional de Agricultura Tropical

Centro Internacional de Mejoramiento de Maiz y Trigo

Comité inter-Etats de lutte contre la sécheresse dans le Sahel

Food and Agriculture Organization of the United Nations

International Board for Plant Genetic Resources

International Centre for Research in Agroforestry

International Crops Research Institute for the Semi-Arid Tropics

International Fertilizer Development Center

International Institute for Tropical Agriculture

International Laboratory for Research on Animal Diseases

International Trypanotolerance Centre

Southern African Centre for Cooperation in Agricultural Research

Staff list, 1991

Professional and supervisory staff

DIRECTOR GENERAL's OFFICE

J Walsh, *Director General*

Antonio Silla, *Internal Auditor*

J Reeves, *Public Awareness Specialist***

R von Kaufmann, *Assistant to the Director General and Director of the Donor and Board Secretariat*

Tehout Workalemahu, *Executive Secretary*

I Alipui, *Executive Assistant (Donor and Board Secretariat)*

RESEARCH DEPARTMENT

H Fitzhugh, *Deputy Director General (Research)*

A K Dial, *Programme Liaison Officer, West Africa*

J A Kategile, *Programme Liaison Officer, East/Southern Africa*

A Tall, *Research Operations Manager*

Animal Science Division

A Lahlou-Kassi, *Animal Scientist (Head of Division)**

Animal Nutrition and management

D O Anindo, *Animal Nutritionist (Post-doctoral associate)**

C B O'Connor, *Dairy Technologist*

M Moens, *Dairy Technologist (FAO Associate Specialist)***

A N Said, *Animal Nutritionist/ARNAB Coordinator*

Animal Production and management

D L Coppock, *Animal Scientist/Ecologist***

W Mwenya, *Animal Breeder (Visiting Scientist)***

P Osuji, *Cattle Milk and Meat Thrust Coordinator*

S Sibanda, *Animal Scientist (Post-doctoral Associate)***

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* Joined ILCA in 1991

** Left ILCA in 1991

Small Ruminant Research Network
B Rey, *Veterinarian/Animal Production Scientist (seconded from the Institut d'élevage et de médecine vétérinaire des pays tropicaux)*

Animal Reproduction and Health

O B Kasali, *Veterinarian/Pathologist (Head of Section)***

Azage Tegegne, *Veterinarian (Post-doctoral Associate)***

E G Mukasa-Mugerwa, *Animal Scientist*

Tamrat Yigzaw, *Chief Laboratory Technician***

Tekelye Bekele, *Veterinarian*

P Viviani, *Veterinarian (FAO Associate Expert)***

S Sovani, *Associate Scientist**

Animal Breeding

J E O Rege, *Animal Breeder**

Plant Science Division

D Thomas, *Forage Agronomist (Head of Division)***

D Siaw, *Agronomist (Post-doctoral Associate)*

Genetic Resources

J Hanson, *Head of forage Genetic Resources Section*

J H Heering, *Agronomist (Associate Expert)*

M van de Wouw, *Zwai Site Coordinator*

Herbage Seed Unit

R Griffiths, *Seed Production Specialist (Head of Unit)*

Mare Tsega, *Agronomist/Physiologist (Post-doctoral Associate)**

Soils and Plant Nutrition

I Haque, *Soil Scientist (Head of Section)*

E A Aduayi, *Soil Scientist (Visiting Scientist)***

Tekalegn Tadesse, *Chief Research Assistant*

Livestock Economics Division

S Sandford, *Economist (Head of Division)***

Addis Anteneh, *Economist***

E Betubiza, *Economist (Post-doctoral Associate)**

R Brokken, *Economist***

S Ehui, *Economist*

Senait Seyoum, *Chief Research Assistant***

B Shapiro, *Economist**

Research Support Division

Computer Science and Biometrics

E Bruns, *Manager, Computer Services*

T Metz, *Scientific Programmer*

J Sherington, *Biometrician*

Experiment Station–Debre Birhan

Negussie Akalework, *Station Coordinator/Project Supervisor*

Experiment Station–Debre Zeit

S Crosse, *Animal Scientist (Team Leader)*

H Khalili, *Animal Nutritionist (Associate Scientist)*

I Nsahlai, *Animal Nutritionist (Post-doctoral Associate)**

Tadesse Tessema, *Station Coordinator***

Experiment Station–Headquarters

Aklilu Askabe, *Animal Scientist (Farm and Grounds Manager)***

Resource Survey

Assefa Eshete, *Photo Interpreter***

Michel Corra, *Ecologist***

Tassew G/Medhin, *Pilot***

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* joined ILCA in 1991

**** Left ILCA in 1991

Zonal Research Sites

Highlands–Ethiopia

M A Mohamed-Saleem, *Agronomist (Team Leader)*

Abate Tedla, *Forage Agronomist*

Abiye Astatke, *Agricultural Engineer*

Getachew Asamenew, *Agricultural Economist*

U Schulthess, *Agronomist (Research Associate*)**

K L Srivastava, *Soil and Water Engineer (ICRISAT)*

T Varvikko, *Animal Nutritionist (Associate Scientist)*

E Zerbini, *Animal Scientist**

Humid Zone–Nigeria

M A Jabbar, *Agricultural Economist*

E Sabiiti, *Range Ecologist (Post-doctoral Associate)***

A Larbi, *Forage Agronomist**

J Smith, *Animal Scientist**

Subhumid Zone–Nigeria

E Agishi, *Agronomist***

J Agwu, *Reproductive Physiologist (Post-doctoral Associate)*

H Jansen, *Livestock Economist***

P Lawrence, *Animal Traction Network Coordinator*

M Peter, *Head of Administration and accounts*

G Tarawali, *Forage Agronomist*

S A Tarawali, *Associate Scientist**

O·Ikwuegbu, *Animal Scientist*

Subhumid/Semi-arid Zone–Mali

S Debrah, *Economist***

D Diakite, *Administrator*

L Diarra, *Ecologist*

K Fofana, *Chief Accountant*

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* joined ILCA in 1991

**** Left ILCA in 1991

P Hiernaux, *Ecologist*

D Mamadou, *Biometrician**

E A Olaloku, *Cattle Research Network Coordinator*

A Reese, *Animal Scientist***

S Soumare, *Sociologist*

Trypanotolerance/Subhumid Zone–Kenya

R L Baker, *Animal Breeder*

B H Dzowela, *PANESA Coordinator***

G d'Ieteren, *African Trypanotolerant Livestock Network Coordinator*

S H B Lebbie, *Small Ruminant Research Network Coordinator**

P N de Leeuw, *Ecologist*

G Mullins, *Agricultural Economist (Post-doctoral Associate)*

S M Nagda, *Senior Biological Data Analyst*

M Oriaro, *Administrative and finance Officer*

A Ouattara, *Bilingual Assistant to the Network Coordinator*

J M Rarieya, *Biological Data Analyst*

L Reynolds, *Small Ruminant Meat and milk Thrust Coordinator*

G J Rowlands, *Animal Production Scientist*

B M Swallow, *Agricultural Economist**

W Thorpe, *Animal Scientist*

Semi-arid Zone–The Gambia

K Agyemang, *Animal Production Scientist*

D Little, *Animal Nutritionist*

Semi-arid Zone–Niger

J M Powell, *Agro-ecologist (Team Leader)*

S Fernandez Rivera, *Animal Scientist**

Z C Somba, *Plant Nutritionist (Post-doctoral Associate)**

T O Williams, *Livestock Economist*

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* joined ILCA in 1991

**** Left ILCA in 1991

Network Sites

Network site – Trypanotolerance, Ethiopia

Woudyalew Mulatu, *Veterinarian*

GOVERNMENT RELATIONS IN AFRICA

M Sall, *Director of Government Relations in Africa*

TRAINING AND INFORMATION DEPARTMENT

M E Smalley, *Director of Training and Information*

Training

L Padolina, *Head, Training Programmes Unit*

B R Tripathi, *Head, Training Materials and Methods Unit*

Werqu Mekasha, *Training and Conference Officer*

Information

L J Haravu, *Head of Information***

S Adoutan, *Translator/Editor*

Azeb Abraham, *Librarian*

Marcos Sahlu, *Supervisor, Documentation*

P J H Neate, *Science Writer*

D Niang, *Revisor/Editor*

J Stares, *English Editor/Writer**

C De Stoop, *Assistant Translator*

GENERAL SERVICES

W Michel, *Head of General Services***

E J English, *Head of General Services**

Alemayehu W/Giorgis, *Travel Officer*

G Daniels, *Manager, Housing and Catering***

Ephraim Bekele, *Liaison Service Officer*

F Leone, *Physical Plant Manager*

P Monaia, *Supervisor, Maintenance*

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* joined ILCA in 1991

****** Left ILCA in 1991

B R R Rao, *Manager, Housing and Catering**

Sahle Kebede, *Catering Officer*

Tafesse Akale, *Protocol Officer*

Tekeste B Habtu, *Procurement Officer*

Tesfaye Mekoya, *Chief Safety Officer*

PERSONNEL DIVISION

B K Johri, *Personnel Manager*

Ahmed Osman, *Assistant Personnel Officer*

Tadesse Minas, *Assistant Personnel Officer*

FINANCE

M Klass, *Financial Controller*

Belayhoun Wondimu, *Chief Accountant*

Emmanuel Tesfa Mariam, *Budget Officer*

Kiros Tsegaye, *Supervisor, Disbursement and Collection*

Negussie Abraham, *Supervisor, General Accounts*

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* joined ILCA in 1991

** Left ILCA in 1991

Post-doctoral and Graduate Associates at ILCA in 1991

Post-doctoral Associates

Start	End	Name/ nationality	Project title	Thrust*/ country
1989	1991	Azage Tegegne, Ethiopian	Comparative reproductive physiology in zebu crossbred cattle, and embryo transfer experimentation	C/Ethiopia
1989	1991	Asamoah Larbi, Ghanaian	Initial forage evaluation and feeding management	AFR/ Ethiopia
1989	1991	Ercole Zerbini, Italian	Effect of work on milk production and reproduction in crossbred dairy cows	AT/Ethiopia
1989	1991	Daniel Siaw, Ghanaian	Evaluation of *Sesbania* spp accessions at Debre Zeit	AFR/Ethiopia
1989	1991	Elly N Sabiiti, Ugandan	Alley farming in the humid zone of Nigeria	AFR/Nigeria
1990	1991	Simbarashe Sibanda, Zimbabwean	Feeding and management of crossbred dairy calves and of sheep	C/SR/ Ethiopia
1990	1992	Gary Mullins, American	Study of the economics of cattle milk and dairy products consumption and marketing and small ruminant production and marketing survey	C/SR/Kenya
1991	1993	Mare Tsega, Ethiopian	Determination of optimum forage seed harvest dates and their drying and storage characteristics	AFR/Ethiopia
1991	1993	David O Anindo, Kenyan	Development of feed evaluation models	C/Ethiopia
1991	1993	Eustacius Betubiza, Ugandan	Influence of producer cooperatives in technology diffusion across smallholder farming communities in the Ethiopian highlands	LPRU/ Ethiopia
1991	1993	Ignatius Nsahlai, Cameroonian	Mechanisms of protein and energy utilisation by ruminants fed diets made of low quality feed stuffs	C/Ethiopia
1991	1993	Zana C Somba, Burkinabe	Nutrient cycling by ruminants in mixed farming systems in semi-arid sub-Saharan Africa	SR/Niger

* C = Cattle Milk and Meat; SR = Small Ruminant and Milk; AT = Animal Traction; AFR = Animal Feed Resources; LPRU = Livestock Policy and Resource Use.

Graduate Associates

Start	End	Name/ nationality	University/ institute	Degree	Project title	Thrust*/ country
1986	1992	Yemi Akinbamijo, Nigerian	Agricultural University, Wageningen	PhD	Studies on aspects of trypanosomiasis and West African Dwarf sheep production	SR/Nigeria
1988	1991	Norbert Steinmuller, German	University of Hohenheim	PhD	Genetic resources and management of *Sesbania sesban* and *S. goetzei* in the semi- and mid-altitude zone and semi-humid high-altitude zone of Ethiopia	AFR/ Ethiopia
1988	1991	Susan Hoefs, German	University of Göttingen	PhD	Evaluation of feed resources available in the Sahel through intake, digestion and metabolism trials	SR/Niger
1988	1992	Ikechukwu Ezenwa, Nigerian	University of lbadan	PhD	Strategic management of tree-based pastures for dry-season fodder production in southern Nigeria	AFR/ Nigeria
1988	1991	Boubacar Hassane, Nigerien	Utah State University	PhD	Economics of cattle production/multi-locational testing of fodder banks	C/Nigeria
1988	1991	Kezie Buyebinam, Togolese	University of Göttingen	PhD	Prospects for improved small ruminant production in farming systems of the humid zone in Togo	SR/Nigeria
1989	1992	A S Tening, Cameroonian	University of Ibadan	PhD	Potassium requirements of grass/legume mixtures in the soils of the subhumid zone of Nigeria	AFR/ Nigeria
1989	1991	Solomon Mogus, Ethiopian	Institut für Tierernahrung	PhD	Effect of processing oilseed cakes on their nutritive value: *in vitro* N-degradability and nitrogen metabolism in growing sheep fed a basal diet of maize stover	C/Ethiopia
1989	1991	Gashaw Geda, Ethiopian	Alemaya University of Agriculture	MSc	Assessment of the feed resource base and performance of crossbred dairy cows distributed to smallholders in the Selale development project	C/Ethiopia
1989	1991	Christophe N Kouame, Ivoirien	University of Florida	PhD	Introduction of forage legumes in Sahelian cropping systems	SR/Niger
1989	1992	Seiffuddin H Maloo, Kenyan	University of Glasgow	PhD	Vector-borne diseases and preventive-medicine programmes in smallholder dairy cattle in coastal Kenya	C/Kenya
1989	1992	Rehab W Muinga, Kenyan	University of Aberdeen	PhD	Dairy cow nutrition for smallholder dairy production systems in coastal subhumid Kenya	C/Kenya

* C = Cattle Milk and Meat; SR = Small Ruminant Meat and Milk; AT = Animal Traction; AFR = Animal Feed Resources; LPRU. = Livestock Policy and Resource Use.

Graduate Associates (cont'd)

Start	End	Name/ nationality	University/ institute	Degree	Project title	Thrust*/ country
1989	1991	Joseph G Mureithi, Kenyan	University of Reading	PhD	Agronomy of forages and crops for smallholder dairy production systems in coastal subhumid Kenya	C/Kenya
1989	1992	Abdi Adam Jama, Somali	Texas A & M University	PhD	Evaluation of forage legume genetic resources for the subhumid zone of West Africa	AFR/ Nigeria
1990	1992	Otto Wiegand, American	University of Wisconsin	PhD	Microbial metabolism of protein from MPTs in the rumen	SR/ Ethiopia
1990	1991	Bekele Shiferaw, Ethiopian	Agricultural University of Norway	MSc	Assessment of land-use conflicts for livestock production/contributions of crop–livestock integration for sustainability of agriculture in the Ethiopian highlands	LPRU/ Ethiopia
1990	1991	Daniel Dauro, Ethiopian	University of Montpellier	PhD	Competition and regeneration patterns of selected Trifoliums under natural pasture and intercropped situations in the Ethiopian highlands	AFR/ Ethiopia
1990	1991	Yohannes Kebede, Ethiopian	McGill University	PhD	Crossbred dairy technology in Selale	LPRU/ Ethiopia
1989	1990	Lulseged Gebre Hiwot, Ethiopian	University of Missouri-Columbia	PhD	The productivity of selected tropical and temperate grass species interseeded with selected annual legumes during the year of establishment	AFR/ Ethiopia
1990	1991	Kidane Gebre Meskel, Ethiopian	Alemaya University of Agriculture	MSc	Harvesting native hay for optimum quality and quantity in the central Ethiopian highlands	C/Ethiopia
1990	1992	Stefan Kachelriess, German	Justus Liebig University	PhD	Management practices for seed multiplication of selected forage legumes in northern Nigeria	AFR/ Nigeria
1990	1992	Emmanuel Osafo, Ghanaian	University of Reading	PhD	Improving the use of sorghum stover as ruminant feed in Ethiopia	SR/ Ethiopia

C = Cattle Milk and Meat; SR = Small Ruminant Meat and Milk; AT = Animal Traction; AFR = Animal Feed Resources; LPRU = Livestock Policy and Resource Use.

Graduate Associates (cont'd)

Start	End	Name/ nationality	University/ institute	Degree	Project title	Thrust*/ country
1990	1991	Felix N Ikpe, Nigerian	Rivers State University of Science and Technology	PhD	Manure management for cropping	LPRU/ Niger
1990	1991	Calvin Antonza II, Nigerian	Ahmadu Bello University	PhD	Social and economic constraints to the introduction of animal traction	AT/Nigeria
1991	1992	Victor Okoruwa, Nigerian	University of Ibadan	PhD	Economics of alternative cattle production systems in SW Nigeria	LPRU/ Nigeria
1991	1992	Michael Bonsi, Ghanaian	University of Science and Technology	MSc	Mechanisms of protein and energy utilisation by ruminants fed low quality feedstuffs	C/ Ethiopia
1991	1992	Tesfaye W/Michael, Ethiopian	Alemaya University of Agriculture	MSc	Effect of work on oxen of different body conditions used for traction	C/ Ethiopia
o						
1991	1992	Jeroen Dijkman, Dutch	University of Edinburgh	MSc	Study on oxygen consumption of oxen working under different conditions	AT/Nigeria
1991	1992	Paul A Iji Nigerian,	Ahmadu Bello University	MSc	Productivity of West African Dwarf goats on improved pasture	SR/ Nigeria

* C = Cattle Milk and Meat; SR = Small Ruminant Meat and Milk; AT = Animal Traction; AFR = Animal Feed Resources; LPRU = Livestock Policy and Resource Use.

Publications by ILCA staff in 1991

Annual reports

ILCA 1990: Annual report and programme highlights. 84 pp.
ILCA annual programme report 1990. 207 pp.

Journal

African Livestock Research Vol 1, no. 1, January 1992.

Research report

Debrah S and Berhanu Anteneh. 1991. *Dairy marketing in Ethiopia: Markets of first sale and producers' marketing patterns.* ILCA Research Report 19. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 21 pp.

Monograph

Hoste C H, Chalon E, d'Ieteren G D M et Trail J C M. 1991. *Le bétail trypanotolerant d'Afrique occidentale et centrale Tome 3. Bilan d'une décennie.* Monographie du CIPEA n° 2. CIPEA (Centre international pour l'élevage en Afrique), Addis-Abeba (Ethiopie). 281 pp.

Systems study

Solomon Bekure, de Leeuw P N, Grandin B E and Neate P j H (eds). 1991. *Maasai herding: An analysts of the livestock production system of maasai pastoralists in eastern Kajiado District, Kenya.* ILCA Systems Study 4. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 172 pp.

Newsletters

ILCA Newsletter Vol 10 (Nos 1, 2, 3 and 4)
CIPEA Actualités Vol 10 (Nos 1, 2, 3 and 4)

Manuals

ILCA (International Livestock Centre for Africa). 1991. *Financial procedures manual.* ILCA, Addis Ababa, Ethiopia.

ILCA (International Livestock Centre for Africa). 1991. *Information on ILCA's governance.* ILCA, Addis Ababa, Ethiopia.

ILCA (International Livestock Centre for Africa). 1991. *Information policy and procedures manual.* ILCA, Addis Ababa, Ethiopia. 85 pp.

O'Connor C B and Tripathi B R. 1991. *An introduction to milk.* Rural dairy processing training series. Audiotutorial module 1. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 24 pp.

O'Connor C B et Tripathi B R. 1991. *Introduction à l'étude du lait.* Série Techniques de transformation du lait en milieu rural. Cours audiovisuel-Module 1. CIPEA (Centre international pour lélevage en Afrique), Addis-Abeba (Ethiopie). 24 pp.

Tripathi B R. 1991. *Roles of visuals in scientific presentations.* Communication instruction series. Audiotutorial module 1. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 24 pp.

Tripathi B R. 1991. *Rôle des supports visueIs dans la communication scientifique.* Série Techniques de communication. Cours audiovisuel-Module 1. CIPEA (Centre international pour lélevage en Afrique), Addis-Abeba (Ethiopie). 24 pp.

Tripathi B R. 1991. *Speaking at scientific meetings: Organising the message.* Communication instruction series. Audiotutorial module 2. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 20 pp.

Indexes/bibliographies

ILCA (International Livestock Centre for Africa). 1991. *ILCA in print. Supplement 2. Publications du CIPEA Supplement n^{o} 2.* ILCA, Addis Ababa, Ethiopia. 58 pp.

Mekonnen Assefa (élaborépar). 1991. *Index des documents microfichés au Mali.* CIPEA (Centre international pour l'élevage en Afrique), Addis-Abeba (Ethiopie). 238 pp.

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Financial Summary

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
BALANCE SHEET at 31 December 1991

(US$ '000)

ASSETS

	1991	1990
Cash and banks	10 234	8 906
Receivable from:		
- donors	1 718	1 185
- employees	147	120
- others	1 417	1 898
Inventories	1 443	1 460
Deposits and prepayments	266	201
Total current assets	15 220	13 770
Construction work in progress	188	63
Fixed assets	10 977	11 681
Total assets	26 385	25 514

LIABILITIES AND FUND BALANCES

Accounts payable:		
- employees	384	372
- trade	500	532
- others	1 988	1 384
Contributions received in advance	1 330	1 449
Commitments	1 027	1 789
Accruals	2 871	2 045
Total current liabilities	8 100	7 571
Working fund	7 308	6 262
Invested in fixed assets	10 977	11 681
Total fund balances	18 285	17 943
Total liabilities and fund balances	26 385	25 514

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
STATEMENT OF INCOME AND EXPENDITURES
for the year ended 31 December 1991

(US$ '000)

Revenue	**1991**	**1990**
Donations pledged	19 859	20 904
Interest income	560	628
Internal recharges	279	365
Other income	798	2 110
Total revenue	21 496	24 007
Operating expenditure		
Research	12 035	13 534
Information services	1 260	1 224
Training and conferences	1 335	1 479
General administration operations	3 672	3 795
Board and management	1 442	1 005
Depreciation	1 394	1 444
Total operating expenditures	21 138	22 481
Excess of revenue over expenditure	358	1 526
Allocated to:		
Working capital	79	1 161
Capital development fund	279	365

INTERNATIONAL LIVESTOCK CENTRE FOR AFRICA
STATEMENT OF GRANT REVENUE
for the year ended 31 December 1991

(US$ '000)

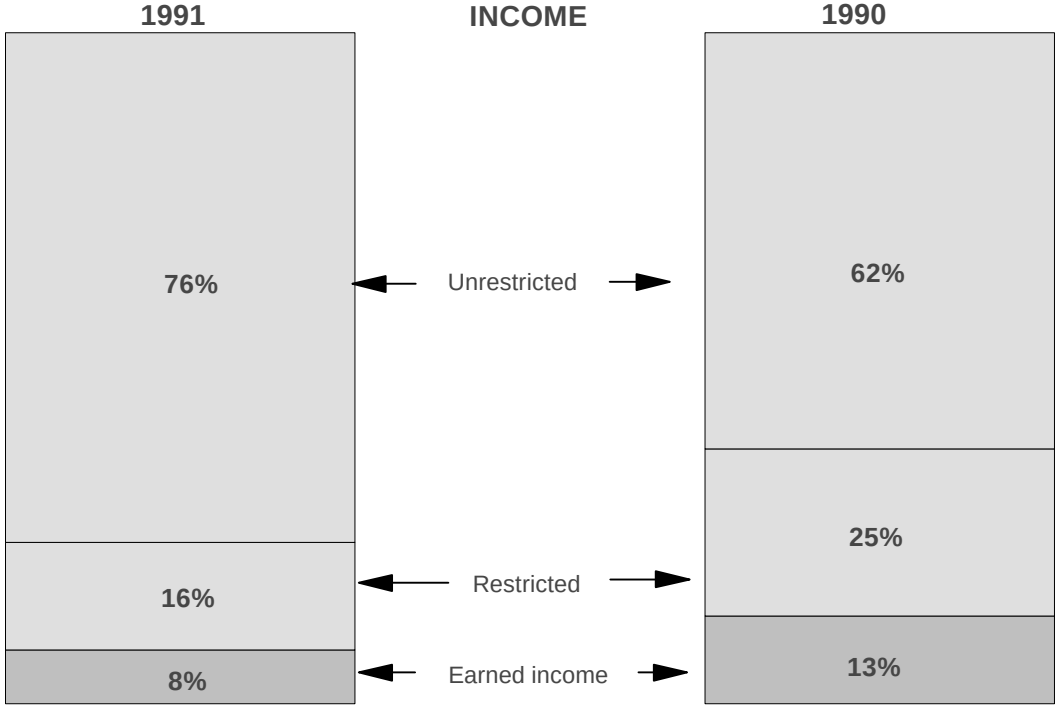
Unrestricted	**1991**	**1990**
African Development Bank (ADB)	250	250
Austria	175	165
Belgium	195	216
Canada	952	958
Denmark	628	492
Finland	1 111	927
France	336	373
Germany	672	584
India	17	24
Ireland	357	311
Italy	178	171
Japan	426	416
Nigeria	19	19
Norway	719	622
Sweden	322	326
Switzerland	1 188	987
The Netherlands	482	408
United Kingdom	602	486
USA	3 000	2 885
World Bank	4 710	4 300
Sub-total	16 339	14 920

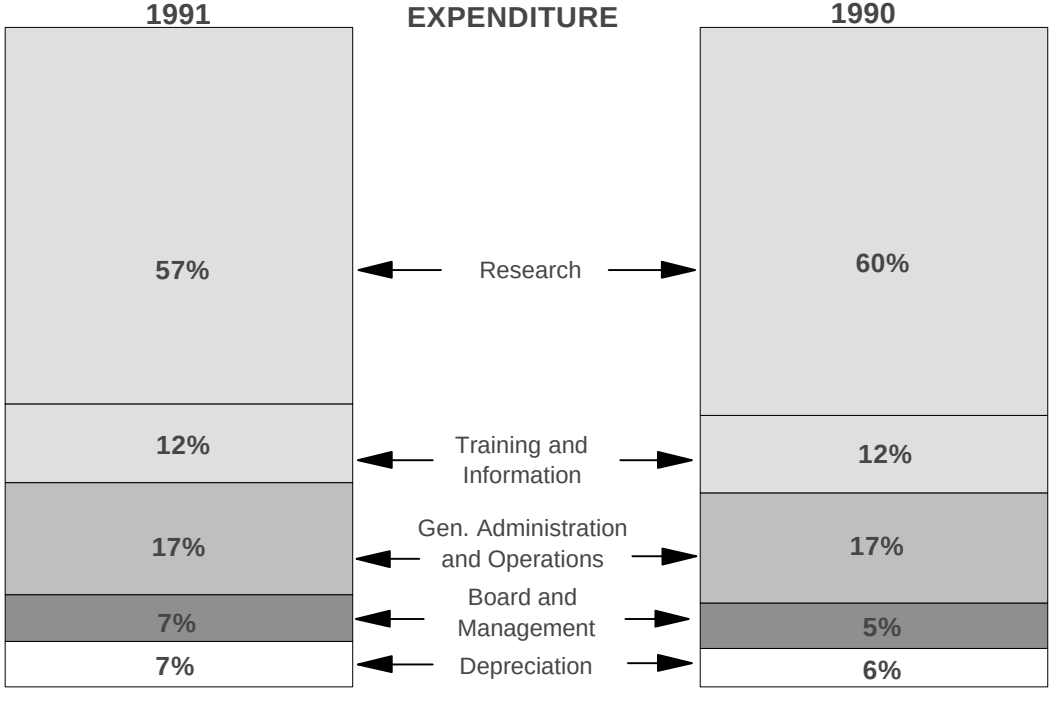
Restricted	**1991**	**1990**
African Development Bank (ADB)	30	33
Australia	0	153
Austria	0	10
Belgium	195	615
EEC	749	1 504
Finland	0	41
FINNIDA	519	335
Ford Foundation	6	12
Germany	374	976
India	17	24
IDRC	304	397
IFAD	0	153
Italy	250	500
Norway	100	150
OPEC	30	0

Statement of grant revenue (cont'd)

	1991	**1990**
PAID	70	0
SIDA	0	58
Switzerland	893	1 046
Sub-total	3 520	5 983
Total grants	19 859	20 903

Source and application of funds, 1991 and 1990





Research expenditure by thrust